

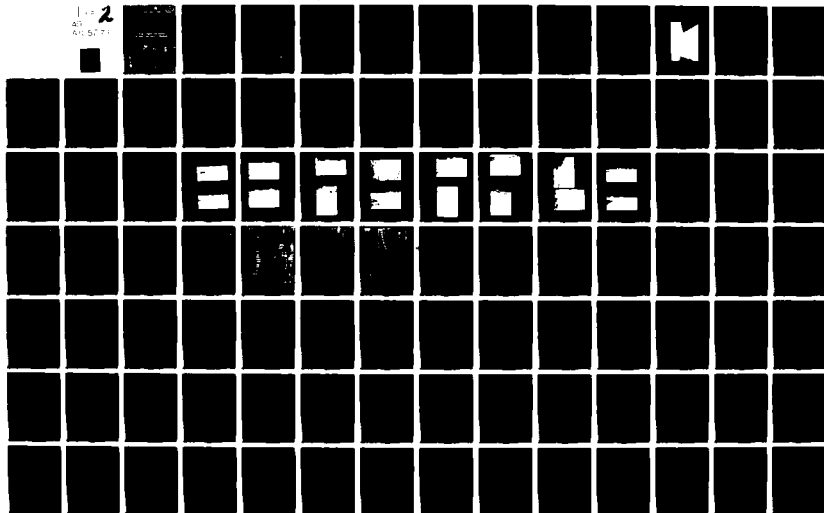
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NATIONAL DAM SAFETY PROGRAM, GRINDSTONE-LOST-MUDDY CREEK DAM F---ETC(U)
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LEVEL II

GRAND-CHURTON DAM

GRINDSTONE-LOST-MUDDY CREEK DAM F-20

DAVISS COUNTY, MISSOURI

MO. 11220

**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**



**United States Army
Corps of Engineers**

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GRINDSTONE-LOST-MUDDY CREEK DAM F-20
DAVISS COUNTY, MISSOURI
MISSOURI INVENTORY NO. 11220

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JUNE, 1980

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DEPARTMENT OF THE ARMY

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

210 TUCKER BOULEVARD, NORTH

ST. LOUIS, MISSOURI 63101

SUBJECT: Grindstone-Lost-Muddy Creek Dam F-20

This report presents the results of field inspection and evaluation of the Grindstone-Lost-Muddy Creek Dam F-20 (MO 11220).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED 29 SEP 1980
Chief, Engineering Division Date

APPROVED BY: SIGNED 30 SEP 1980
Colonel, CE, District Engineer Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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SOIL REPORT AND ENGINEER'S
REPORT, USDA-SCS, 1968

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Division II	Soils Report, USDA-SCS, April, 1968
Division III	Engineer's Report, USDA-SCS, November, 1968

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Grindstone-Lost-Muddy Creek Dam F-20
State Located	Missouri
County Located	Daviess County
Stream	Tributary to Smith Branch
Date of Inspection	June 30, 1980

Grindstone-Lost-Muddy Creek Dam F-20 was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderregger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Grindstone-Lost-Muddy Creek Dam F-20 has a height of twenty-seven (27) feet and a storage capacity at the minimum top elevation of the dam of one hundred (100+) acre-feet. In accordance with the guidelines, a small size dam has a height greater than or equal to twenty-five (25) feet but less than forty (40) feet and a storage capacity greater than or equal to fifty (50) acre-feet but less than one thousand (1,000) acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category. Grindstone-Lost-Muddy Creek Dam F-20 is classified as a small size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high potential for damage and loss of life. Failure would threaten life and property. The estimated damage zone extends approximately two (2) miles downstream of the dam. Within the damage zone are three dwellings, a garage, and a barn.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small volume of water impounded and the downstream channel from the dam, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will not pass the 100-year flood (1% probability flood, a flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 24% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

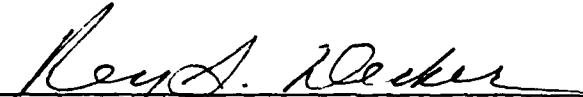
Based on available data and on the field inspection of the dam, the following remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams:

a. Alternatives.

- (1) The emergency spillway size and/or the height of dam should be increased to pass 50% of the Probable Maximum Flood without overtopping.


b. Operating and Maintenance Procedures.

- (1) The vegetative growth around the principal spillway entrance should be removed and the area should be kept clear to prevent a reduction in the principal spillway capacity.
- (2) The willows in the principal spillway outlet channel should be removed and measures taken to prevent their recurrence.
- (3) The dam should be inspected at regular intervals and records of the inspections made a part of the project file on this dam.


Rey S. Decker
E-3703


Gordon Jamison


Garold Ulmer
E-19246


Harold P. Hoskins, Chairman of the Board
Hoskins-Western-Sonderregger, Inc.
E-8696

FORM 1

BUILDING LOGS

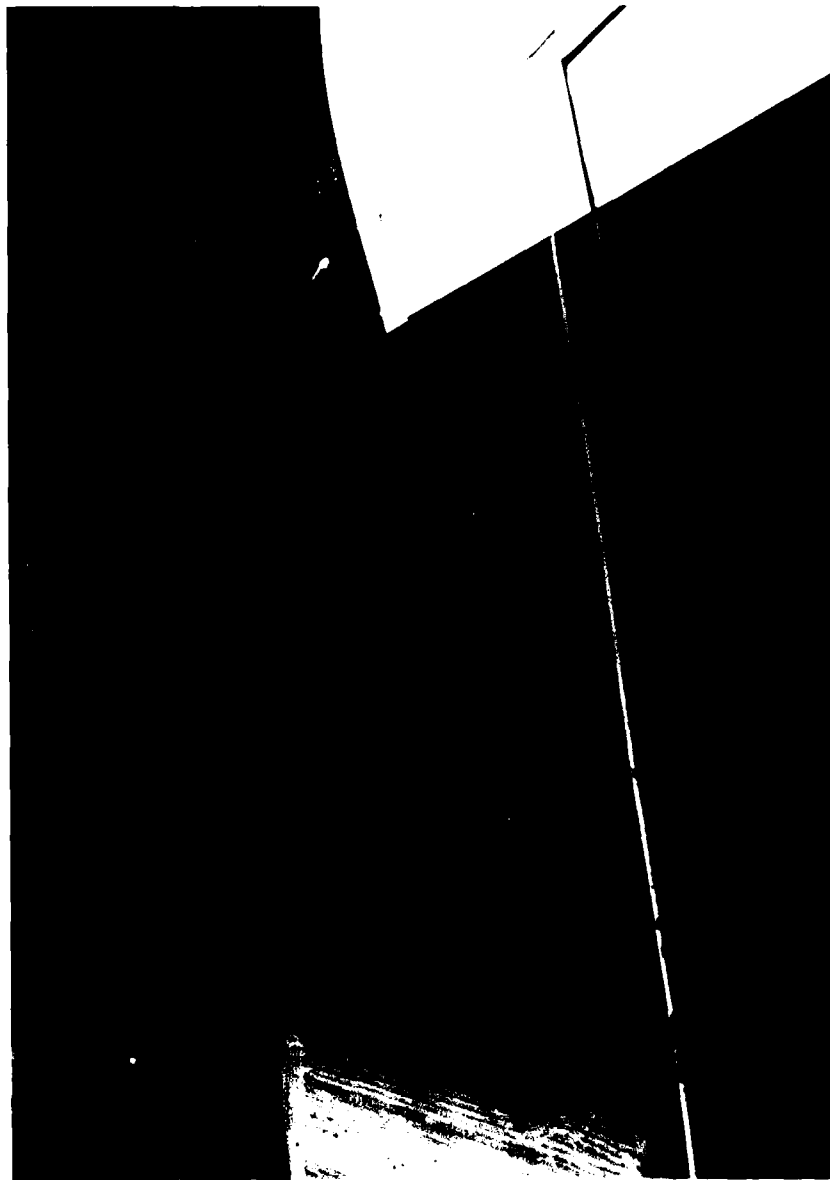


PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
GRINDSTONE-LOST-MUDDY CREEK DAM F-20 - MO 11220
DAVISS COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Grindstone-Lost-Muddy Creek Dam F-20 be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams," dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
 - (1) The dam is an earthen flood control dam about 725 feet in length and 27 feet in height, with a storage capacity at the minimum top of dam of 100± acre-feet. It is located in the Iowa-Missouri Heavy Till Plain Resource area of the Central Lowlands Physiographic area about 5.5 miles west of Altamont, Missouri.
 - (2) The principal spillway consists of a 30-inch corrugated metal pipe drop inlet (riser) with trash rack and antivortex device and a 24-inch corrugated metal pipe conduit passing through the base of the dam.
 - (3) A vegetated earth emergency spillway is cut through the left abutment.
 - (4) Pertinent physical data are given in paragraph 1.3 below.

- b. Location. The dam is located in the extreme western portion of Daviess County about 5.5 miles west of Altamont. It is located in the SW 1/4, Sec. 30, T59N, R29W as shown on Plate A-1.
- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. This dam has a height of 27 feet and a storage capacity at the minimum top elevation of the dam of 100 acre-feet. This dam is classified as a small dam. A small dam has a height greater than or equal to 25 feet but less than 40 feet and a storage capacity greater than or equal to fifty acre-feet but less than 1,000 acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category.
- d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines and on visual observation, this dam is in the High Hazard Classification. The estimated damage zone extends about two miles downstream of the dam. Within the damage zone are three dwellings, a garage and a barn at 0.6 miles.
- e. Ownership. The dam is owned by the Grindstone-Lost-Muddy Creek Watershed Subdistrict, P.O. Box 117, Maysville, Missouri 64469. It is on property owned by Mrs. Gertie Lee, c/o Wesley Lee, Jr., Route 1, Box B-146, Weatherby, Missouri 64497.
- f. Purpose of Dam. The dam was constructed for grade stabilization with flood control features under the Watershed Protection Act, P.L. 566.
- g. Design and Construction History. The dam was designed by the Soil Conservation Service (SCS), Columbia, Missouri. It was constructed in 1975 with the SCS providing technical supervision and quality control during construction.
- h. Normal Operating Procedure. There are no controlled outlet facilities for this dam except the 8-inch diameter drawdown pipe.

1.3 PERTINENT DATA

- a. Drainage Area. 162.0 acres (0.253 square miles).
- b. Discharge at Damsite.
 - (1) All discharges at the damsite are through an uncontrolled 30-inch diameter corrugated metal pipe drop inlet (riser) which is connected to a 24-inch diameter corrugated metal pipe conduit and through an uncontrolled, vegetated earth emergency spillway.

- (2) Estimated maximum flood at damsite - Mr. Wesley Lee reported that the highest water he had seen was approximately 4 inches over the riser.
- (3) The principal spillway capacity varies from 0 c.f.s. at elevation 56.0 feet to 36 c.f.s. at the crest of the emergency spillway (elevation 58.4 feet) to 45 c.f.s. at the minimum top of dam (elevation 60.2 feet).
- (4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation 58.4 feet to 265 c.f.s. at elevation 60.2 feet (minimum top of dam).
- (5) Total spillway capacity at the minimum top of dam is 310 c.f.s. ±.

c. Elevations (feet-assumed).

- (1) Observed pool - 55.4
- (2) Normal pool - 56.0
- (3) Spillway crests
Principal - 56.0
Emergency - 58.4
- (4) Maximum experienced pool - 56.4 ±
- (5) Top of dam (minimum) - 60.2

d. Reservoir. Length (feet) of pool

- (1) At principal spillway crest - 800 ±
- (2) At emergency spillway crest - 900 ±
- (3) At top of dam (minimum) - 1,000 ±

e. Storage (Acre-feet).

- (1) Observed pool - 50 ±
- (2) Normal pool - 55 ±
- (3) Spillway crests
Principal - 55 ±
Emergency - 77 ±

(4) Maximum experienced pool - 56 \pm

(5) Top of dam (minimum) - 100 \pm

f. Reservoir Surface (Acres).

(1) Observed pool - 7.5 \pm

(2) Normal pool - 8.3 \pm

(3) Spillway crests

Principal - 8.3 \pm

Emergency - 10.1 \pm

(4) Maximum experienced pool - 11.5 \pm

(5) Top of dam (minimum) - 12 \pm

g. Dam.

(1) Type - Rolled earth fill

(2) Length - 725 feet \pm

(3) Height - 27 feet \pm

(4) Top width - 14 feet

(5) Side slopes.

(a) Downstream - 1V on 2.5H with 10 foot wide berm

(b) Upstream - 1V on 2.5H with 10 foot wide berm

(6) Zoning - Homogeneous

(7) Impervious core - Homogeneous

(8) Cutoff - Depth varies from 4 to 8 feet, 12 foot bottom width, 1V on 1H side slopes

(9) Grout curtain - None

(10) Wave protection - Vegetated earth berm

(11) Drains - None

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal

(a) Type - Uncontrolled drop inlet with a 30-inch diameter corrugated metal pipe riser and a 24-inch diameter corrugated metal pipe conduit.

(b) Crest (invert) elevation - 56.0

Outlet - 34.0

(c) Length - 124 feet

(2) Emergency

(a) Type - vegetated earth, uncontrolled cut through the left abutment. Bottom width - 40 feet; side slopes - 1V on 3H; exit channel slope - 0.065 ft./ft.

(b) Control section - A level section 30 ft. long near the centerline of the dam.

(c) Crest elevation - 58.3

(d) Upstream Channel - Open and clear

(e) Downstream Channel - Vegetated, slope - 0.065 ft./ft., discharging about 200 feet downstream from the dam.

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

This structure was designed by the Soil Conservation Service, Columbia, Missouri. Copies of the Geologic and Soil Mechanics Reports are included in Appendix E. The plans are included in Appendix C.

2.2 CONSTRUCTION

The dam was constructed in 1975. The SCS provided technical supervision and quality control for the construction.

2.3 OPERATION

No data were available on spillway operation. It was reported by Mr. Wesley Lee that the emergency spillway has never operated.

2.4 EVALUATION

- a. Availability. The data in Appendix C and Appendix E were readily available from the S.C.S.
- b. Adequacy. The design reports, plans, field surveys and visual observation presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" presented in the SCS report in Appendix E are considered adequate.
- c. Validity. The data and analyses are considered valid and adequate.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General. A visual inspection of the Grindstone-Lost-Muddy Creek Dam F-20 was made on June 30, 1980. Engineers from Hoskins-Western-Sonderregger, Inc., Lincoln, Nebraska making the inspection were: Rey S. Decker, Geotechnical; Garold Ulmer and Gordon Jamison, Hydrology and Hydraulics. Mr. Wesley Lee accompanied the inspection team.
- b. Dam.
 - (1) Geology and Soils (Abutment and Embankment). This site is located in the Iowa-Missouri Heavy Till Plains area. Abutments consist of stiff clay till (Kansan) CL-CH. The alluvial valley material consists of stiff silty clay (CL) underlain at shallow depths by siltstone, shale and/or limestone bedrock. Bedrock is exposed in the scour hole at the end of the pipe spillway. Materials in the dam consist of CL-CH material borrowed from the reservoir area and upstream abutments.
 - (2) Upstream Slope. The upstream slope is well vegetated with grass and cattails along the waterline. No slumps or slides were observed, nor was there any erosion. Photo No. 2 shows the upstream slope.
 - (3) Crest. The crest is well vegetated with adapted grasses. Measurements show the crest elevations to be very uniform and according to the plans. No slumps or deformations were observed. A number of drying cracks, up to 1/4 inch wide, were observed on the crest, as shown in Photo No. 11. The same cracking pattern was observed in the emergency spillway which is cut through natural material. The crest is shown in Photo No. 3 and Plate C-10 of Appendix C.
 - (4) Downstream Slope. The downstream slope is well vegetated with adapted grasses. No cracks, slumps or deformations were observed on the slope. Measurements indicate that it was constructed according to the plans. Evidence of an old seep area (dead cattails) was observed downstream from centerline station 6+50. Borings in this area showed no free water to depths of 2 feet. Another seep area occurs downstream from centerline station 5+00 to 6+00. Free water was ponded in this area with no observable flow. Both of these seep areas occur on the berm. Another seep area is located downstream from the berm at about centerline station 5+50. Mr. Lee reported that this seep (spring) was there when the dam was constructed and results

from seepage through the bedrock. Photo No. 4 shows the downstream slope. Photos 12 and 13 show the seeps on the berm.

c. Appurtenant Structures.

- (1) The principal spillway is uncontrolled and consists of a 30-inch corrugated metal pipe riser shown in Photo No. 8 and a 24-inch corrugated metal pipe conduit shown in Photos 14 and 15. The pipe appears to be in good condition. Cattails and grass block part of the entrance to the riser. Cathodic protection measures were installed on the pipe conduit. The activity of the protective measures is monitored by SCS through the "test station" shown on the plans.
- (2) The emergency spillway is an uncontrolled earth channel cut through the left abutment. The spillway is very well vegetated. No slumps or slides were observed in the spillway. There was no evidence of flow through the spillway and no erosion was evident (except for vehicular tracks). Drying cracks similar to those on the crest of the dam were observed in the natural soil in the spillway bottom. Photos 5 and 6 show the spillway.
- (3) Drawdown Facility. The drawdown facility consists of an 8-inch corrugated metal pipe into the 30-inch corrugated metal pipe riser located 4 feet below the crest of the riser.

d. Reservoir Area. The area around the reservoir is well grassed. No slumps or slides were observed. No significant erosion was evident around the shoreline. Photo No. 9 shows a portion of the reservoir.

e. Downstream Channel. The channel downstream from the principal spillway appears to be stable (rock is exposed in the plunge pool). A number of willows are growing in the downstream channel.

3.2 EVALUATION

This dam appears to be in good shape with no serious deficiencies nor potential of failure. Measurements indicate that it was constructed in accordance with the plans. Seepage along the downstream slope does not appear to adversely affect the integrity of the structure. Some minor deficiencies in maintenance (heavy growth of cattails around the entrance to the principal spillway, trees in the outlet channel) should be corrected.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam except the small drawdown pipe. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

Maintenance appears to be reasonably good. Vegetative growth around the inlet of the principal spillway and in the outlet channel should be controlled.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

The maintenance of the dam appears to be good with the exception of the vegetation which has been allowed to grow around the principal spillway inlet and the uncontrolled growth of willow trees in the principal spillway outlet channel.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data. "As built" plans for this dam were furnished by the Soil Conservation Service and are shown in Appendix C. Pertinent hydraulic and hydrologic data used in evaluating the dam are shown in Appendix C, Plate C-9.
- b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the SCS plans. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection and information taken from the "as built" plans.
- c. Visual Observations.
 - (1) The drop inlet pipe, trash rack, and anti-vortex plate appear in excellent condition. However, entrance conditions to the riser are becoming blocked with heavy grass and cattails. The outlet end of the pipe was also in excellent condition.
 - (2) The emergency spillway is very well vegetated with adapted grasses. There is no indication that the emergency spillway has ever operated.
- d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping. The spillways will pass the 1% probability flood as well as 24% of the probable maximum flood without overtopping the dam. Overtopping is dangerous because the flow of water over the crest will erode the face of the dam and, if continued long enough, will breach the dam with sudden release of all of the impounded water into the downstream floodplain.

The results of the routings through the dam are tabulated in regards to the following conditions:

<u>Frequency</u>	<u>Inflow Discharge c.f.s.</u>	<u>Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>*Maximum Depth Over Dam Feet</u>	<u>Duration Over Top Hours</u>
1 %	800	150	59.4	0	---
1/2 PMF	1410	1270	60.9	0.7	2
PMF	2820	2780	61.4	1.2	5
0.2+ PMF	690	310	60.2	0	---

* Minimum top of dam elevation - 60.2

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the 1/2 PMF to PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in paragraph 1.2 d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observation. Measurements indicate that the dam was constructed according to the plans. It is considered to be structurally stable. Stability analyses provided by the SCS show adequate safety factors with phreatic surface developed from emergency spillway elevation and no downstream drainage measures. Therefore, seepage observed in the lower section of the downstream slope should not endanger the safety of the dam from the standpoint of strength. The nature of materials in the dam and foundation indicate that seepage at the toe would not endanger the stability of the dam from the standpoint of internal erosion and piping.
- b. Design and Construction Data. Design data and "As Built" plans were available from the Soil Conservation Service and are included as Appendix C and Appendix E of this report. Seepage and stability analyses presented in the SCS reports are considered adequate for this structure.
- c. Operating Records. There are no controlled operating facilities for this dam.
- d. Post Construction Changes. There have been no post construction changes for this structure.
- e. Seismic Stability. This dam is located in Seismic Zone 1, an earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Safety. The dam appears to be in excellent structural condition with little likely potential of failure. The flood from one-half the Probable Maximum Flood will overtop the dam by 0.7 feet for a period of 2+ hours. Overtopping is dangerous because the flow of water over the crest will erode the face of the dam and, if continued long enough, will breach the dam with sudden release of all of the impounded water into the downstream floodplain. The few minor deficiencies in maintenance should not seriously affect the safety of the structure.
- b. Adequacy of Information. The design data and the "As Built" plans furnished by the SCS and included as Appendix C and Appendix E of this report and the visual observations made during the inspection are considered adequate to support the conclusions and recommendations presented in this report. Seepage and stability analyses presented in the SCS reports are considered adequate for this structure.
- c. Urgency. There does not appear to be an immediate urgency to accomplish the remedial measure recommended in paragraph 7.2a.
- d. Necessity for Further Investigations. Prior to any action being taken on the remedial measure recommended in paragraph 7.2a, the owner should conduct a breach routing of the dam to determine the downstream effects of the failure of the dam.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

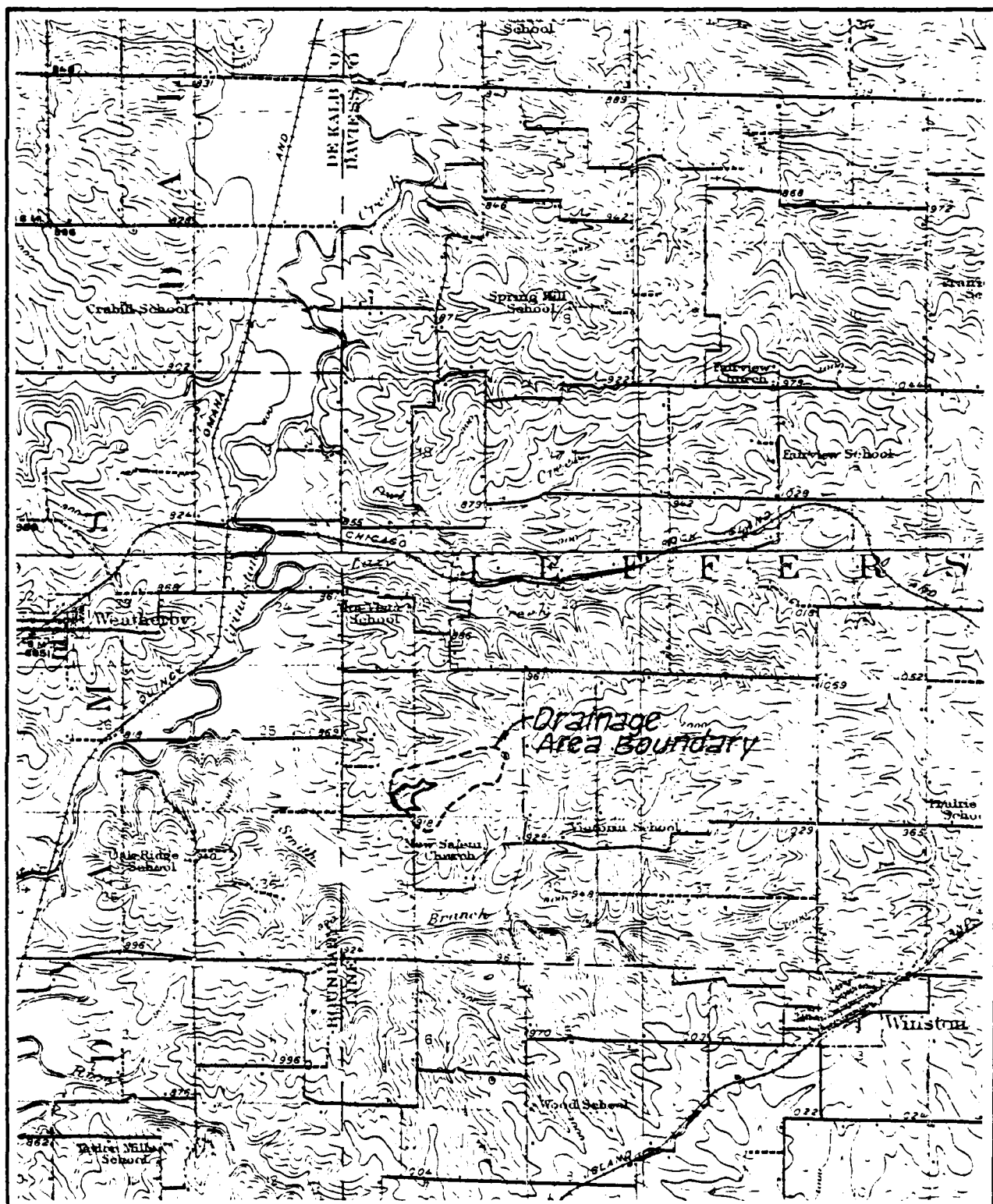
a. Alternatives.

- (1) The emergency spillway size and/or the height of dam should be increased to pass 50% of the Probable Maximum Flood without overtopping.

b. Operating and Maintenance Procedures.

- (1) The vegetative growth around the principal spillway entrance should be removed and the area should be kept clear to prevent a reduction in the principal spillway capacity.
- (2) The willows in the principal spillway outlet channel should be removed and measures taken to prevent their recurrence.
- (3) The dam should be inspected at regular intervals and records of the inspections made a part of the project file on this dam.

APPENDIX A
MAPS



Scale in feet
3000 0 3000 6000 9000 12000

Contour Interval - 20'



VICINITY TOPOGRAPHY

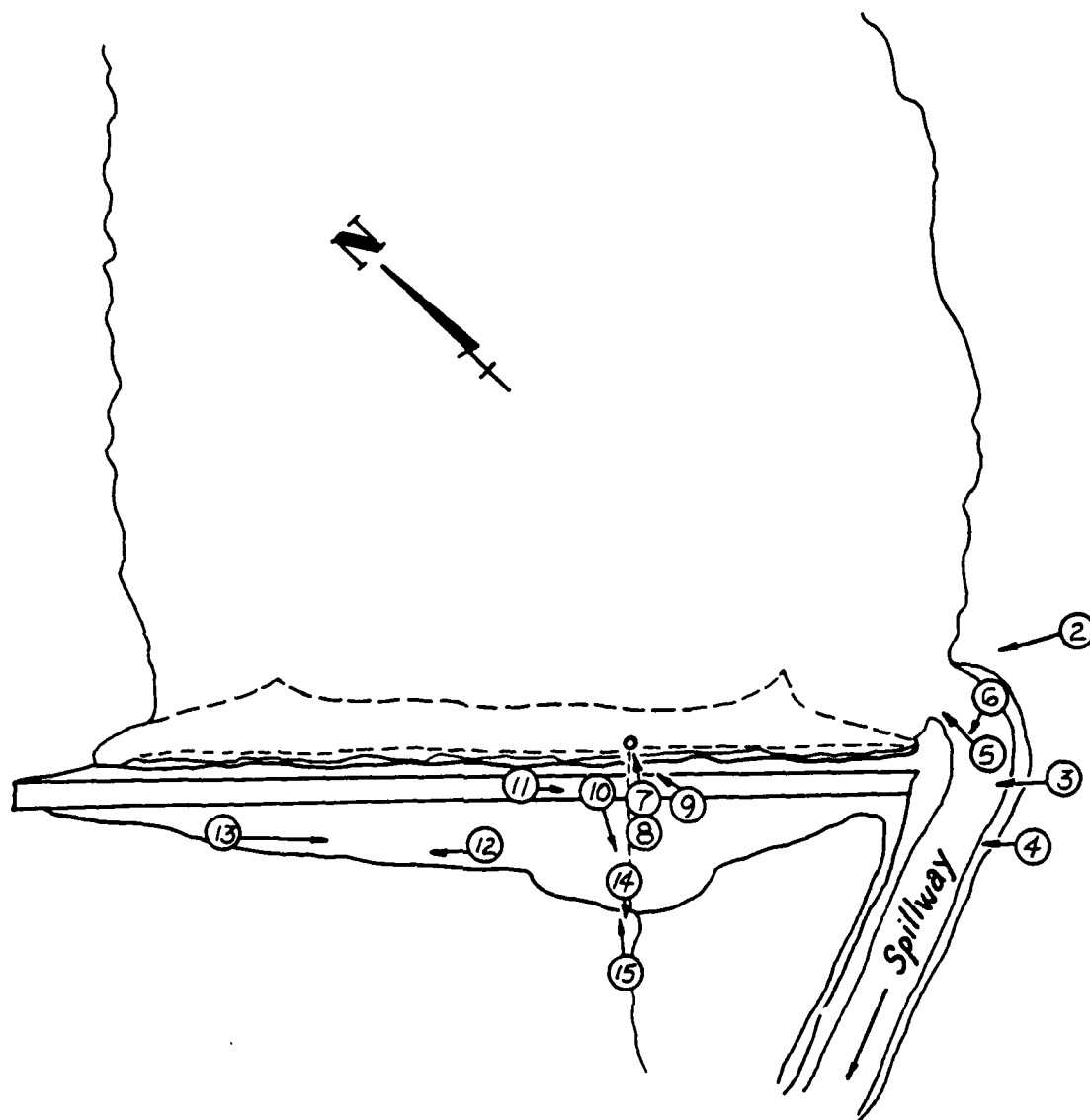
GRINDSTONE-LOST-MUDDY CREEK DAM F-20

DAVIESS COUNTY, MISSOURI

MO. 11220

PLATE A-1

APPENDIX B
PHOTOGRAPHS



GRINDSTONE-LOST-MUDDY CREEK DAM F-20

DAVISS COUNTY, MISSOURI

MO. 11220

PHOTO INDEX

PLATE B-1

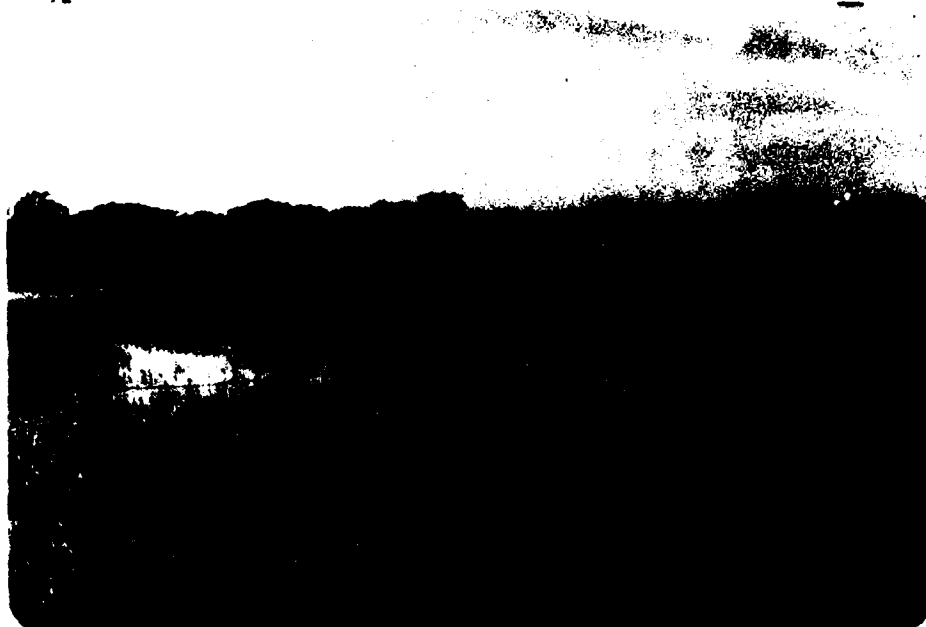


PHOTO NO. 2 - UPSTREAM FACE FROM LEFT ABUTMENT



PHOTO NO. 3 - CREST FROM LEFT ABUTMENT



PHOTO NO. 4 - DOWNSTREAM SLOPE FROM LEFT END



PHOTO NO. 5 - VIEW UPSTREAM IN EMERGENCY SPILLWAY



PHOTO NO. 6 - VIEW DOWNSTREAM IN EMERGENCY SPILLWAY



PHOTO NO. 7 - PRINCIPAL
SPILLWAY RISER



PHOTO NO. 8 - PRINCIPAL SPILLWAY RISER



PHOTO NO. 9 - VIEW UPSTREAM ACROSS PRINCIPAL SPILLWAY RISER



PHOTO NO. 10 - VIEW DOWNSTREAM AT EXIT CHANNEL FOR
PRINCIPAL SPILLWAY

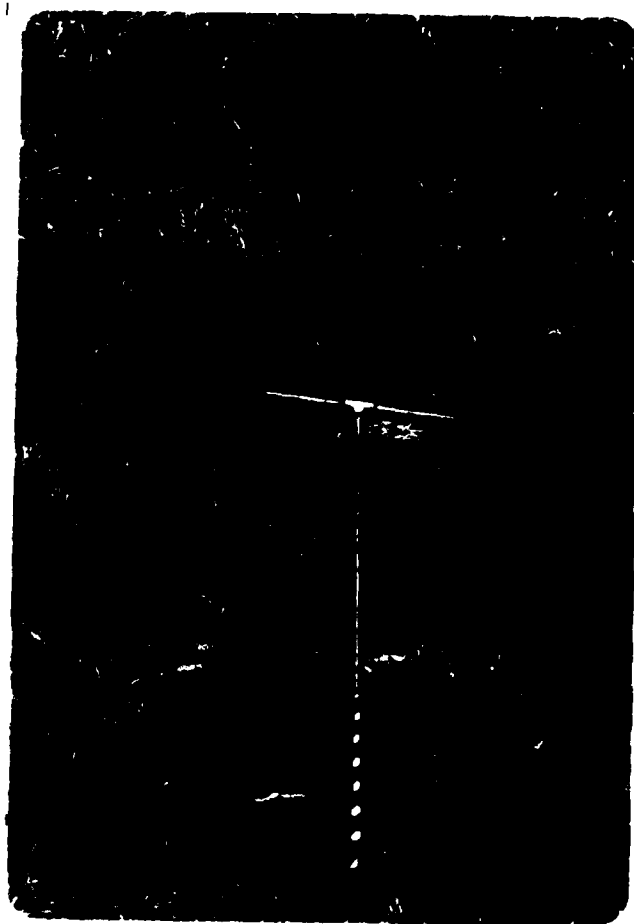


PHOTO NO. 11 -
TRANSVERSE CRACK IN
CREST OF DAM. (IMMEDI-
ATELY TO LEFT OF AUGER)

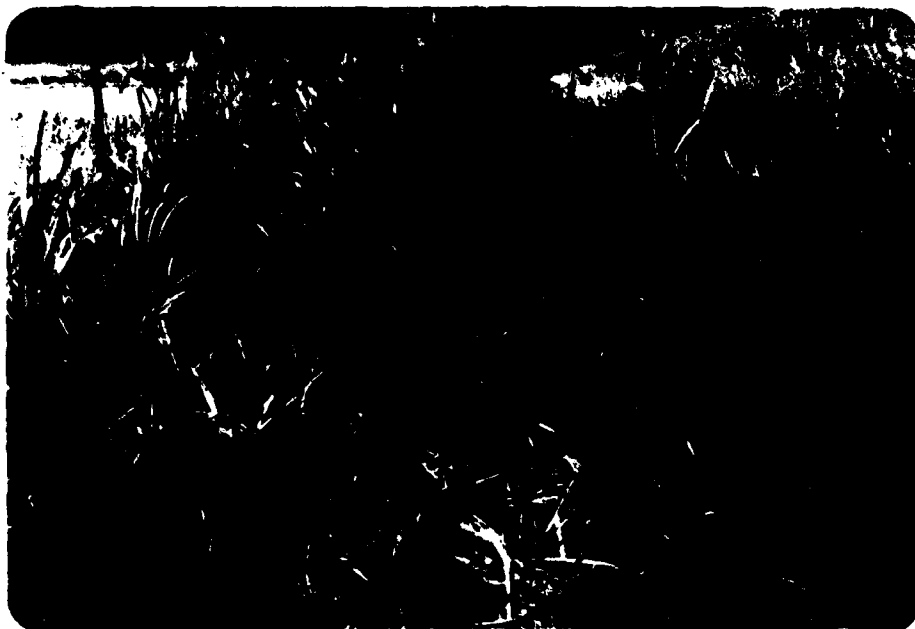


PHOTO NO. 12 - SEEP AREA ON RIGHT DOWNSTREAM TOE

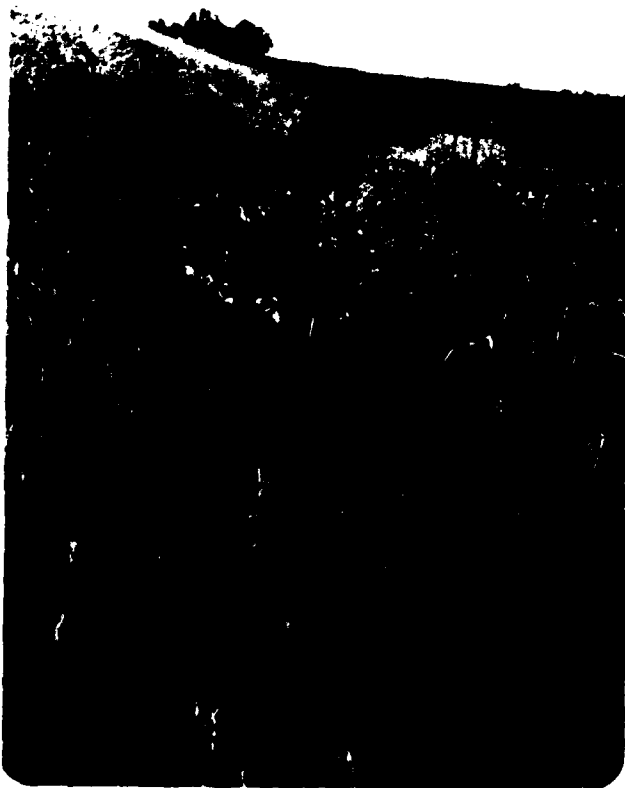


PHOTO NO. 13 - SEEP AREA
NEAR RIGHT DOWNSTREAM
TROUGH



PHOTO NO. 14 - VIEW DOWNSTREAM AT END OF PRINCIPAL SPILLWAY CONDUIT



PHOTO NO. 15 - VIEW UPSTREAM AT PRINCIPAL SPILLWAY OUTLET



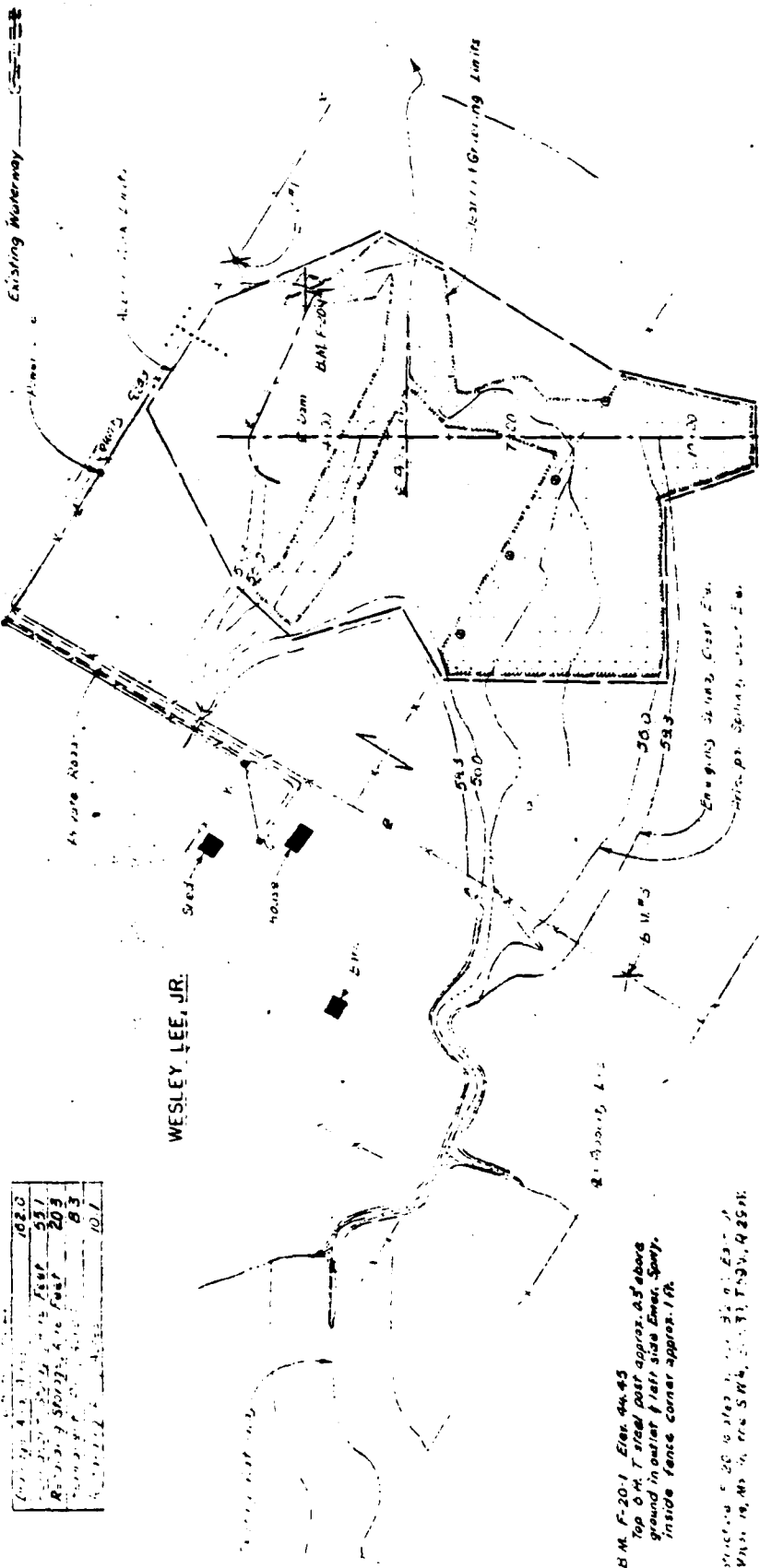
PHOTO NO. 16 - HOME ONE-HALF MILE DOWNSTREAM



PHOTO NO. 17 - HOME AND BARN ONE-HALF MILE DOWNSTREAM

APPENDIX C
PROJECT PLATES

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1.0	1.0
0.5	0.5
0.0	0.0



WESLEY LEE, JR.

MRS. WESLEY LEE, SR.

QUANTITIES
Clearing and Grubbing... Lump Sum
(Approx. 0.3 Acres)

AS BUILT 3-13-25

STRUCTURE F-20
GRANDSTONE-LOST-MUDDY CREEK WATERSHED
P. L. 366
DAVIES CO. MO.
U. S. DEPARTMENT OF AGRICULTURE

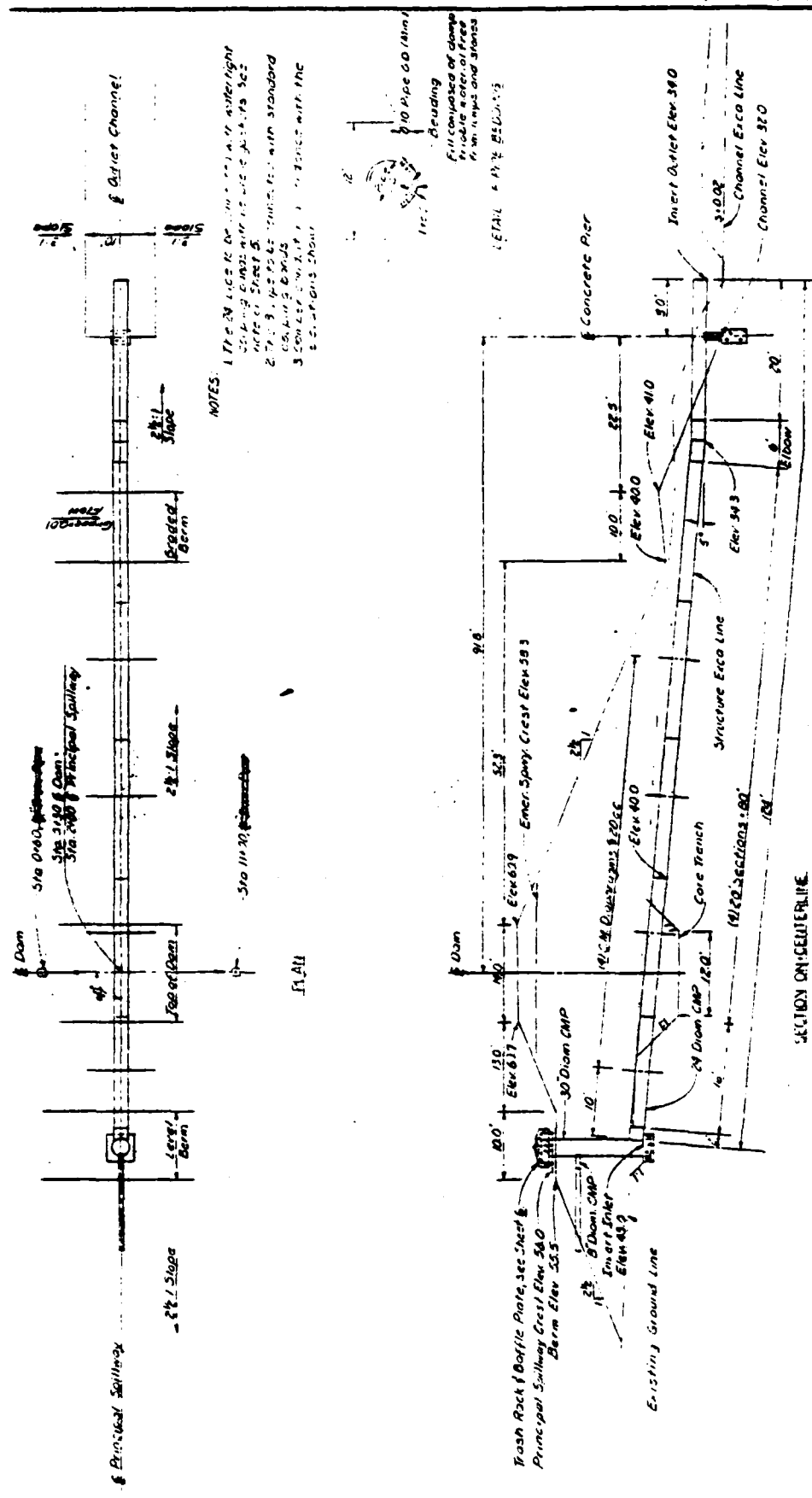
GENERAL PLAN OF RESERVOIR

B.M. F-20-1 Elev. 94.45
Top of M. T. steel post approx. 45' above
ground in outlier flat side East Spout.
Inside fence corner approx. 1 ft.

Structure F-20 is 112' x 112' x 112' East of
Wesley Lee, Jr. the S.W. corner is 33' from the
corner.

B.M. F-20-2 Elev. 94.45
Top of M. T. steel post approx. 45' above
ground in outlier flat side East Spout.
Inside fence corner approx. 1 ft.

B.M. F-20-3 Elev. 94.45
Top of M. T. steel post approx. 45' above
ground in outlier flat side East Spout.
Inside fence corner approx. 1 ft.



NOTES:
 1. The 24\"/>

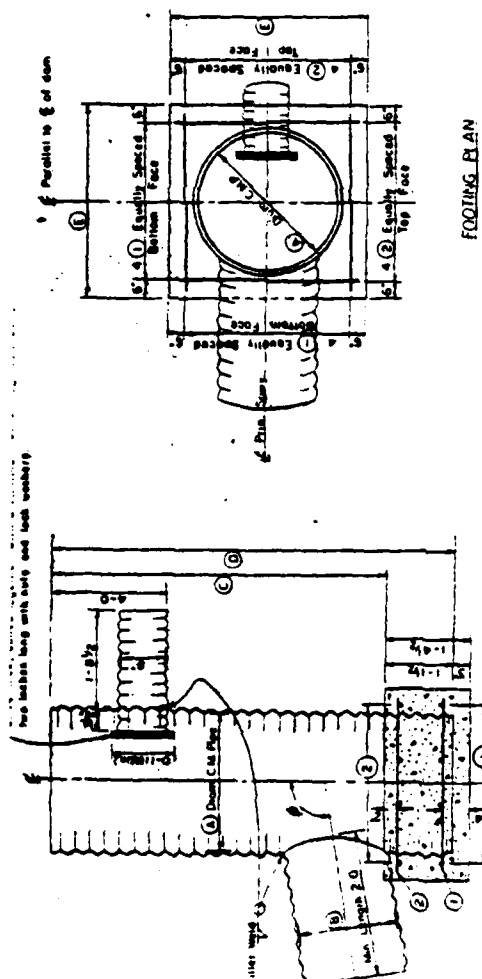
DETAIL 4 1/2\"/>

SECTION ON CENTERLINE
 Scale in Feet

AS BUILT 8-13-25

STRUCTURE F-20
 CMP DROP INLET FOR 24\"/>

MATERIALS



SECTION ON CENTERLINE

FOOTING PLAN

DETAILS OF VERTICAL INLET
NOT TO SCALE

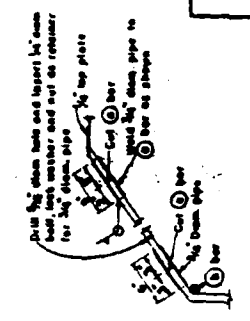
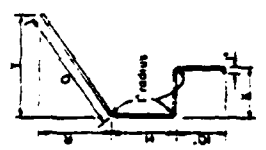
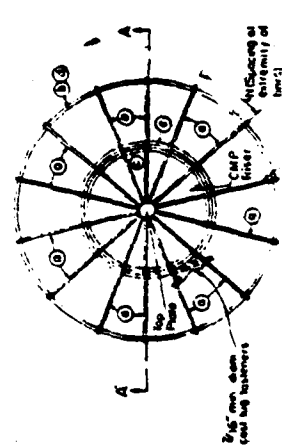
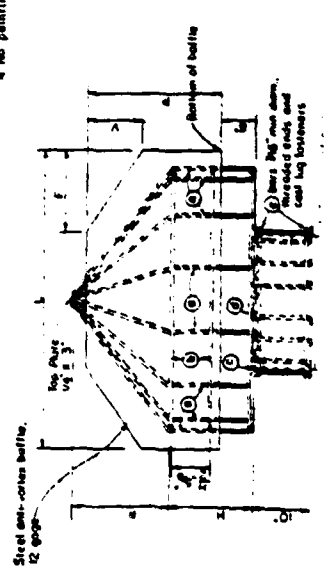
[illegible]

1. Drill $\frac{3}{4}$ " diam holes in the C.M.P. Vertical Inlet as required to clear the reinforcing bars. To be done by manufacturer
2. Sufficient breast wall to be provided to support the vertical inlet on them. The required size and number to be determined by the Contractor. Failing Molds are incidental to the Vertical Inlet.
3. Vertical Inlet to be shop fabricated Materials and Fabrication to be in accordance with Federal Specification WWP-P-405

TABLE OF DIMENSIONS AND MATERIALS FOR TEACH BACK -

No.	Bays			Diam.			Bays			Diam.			Bays			Diam.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
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1. Weld 2 (2) bars to bridle plate. Weld 3 (3) and 4 bars to 10 bars and weld 5 bars to top plate.
2. The iron rods and bridle plate to be fabricated as well.
3. Tryna rock to be fabricated from steel bars conforming to ASTM Specification A-36
4. No painting or galvanizing required



**BENDING DIAGRAM
FOR (c) AND (d) BARS**

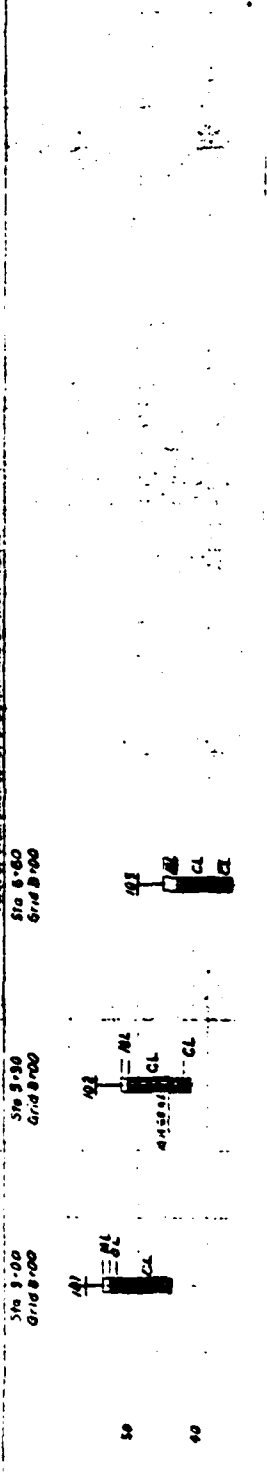
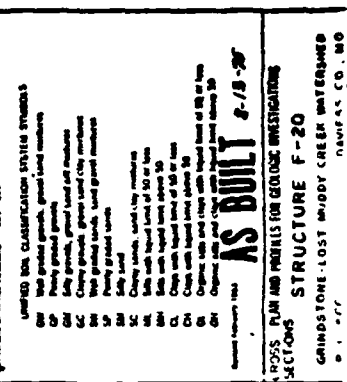
**BENDING DIAGRAM
FOR ⑦ BARS**



**BENDING DIAGRAM
FOR (C) BARS**

AS BUILT 8-13-75
STRUCTURE F-20

STRUCTURE F-20
DETAILS OF CORRUGATED METAL PIPE
VERTICAL INLET AND TRASH RACK
GRINDSTONE-LOST-MUDDY CREEK
WATERSHED PL 566 DAVIESS CO, MO



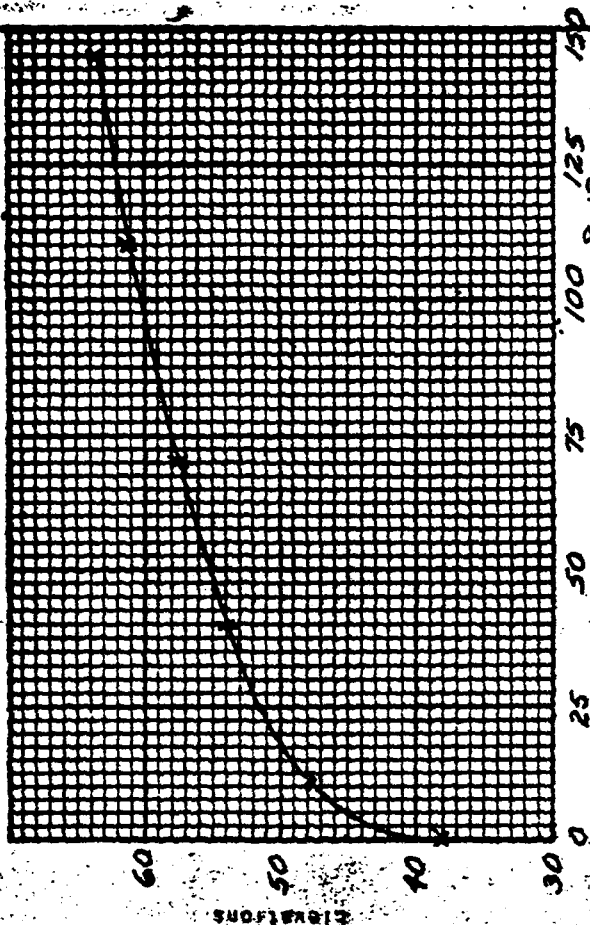
STRUCTURE DATA

Class of Structure 2" Class Stabilization
 Drainage Area (Total) 162 Ac. 0.253 Sq. Mi.
 (uncontrolled) 162 Ac. 0.253 Sq. Mi.
 Time of Concentration 0.25 Hours
 Soil Cover Complex Number 80 For A.M.C. II
 Sediment Capacity Available 55.1 Ac. Ft. below Elev. 56.0
 Total Sediment Capacity Available 55.1 Ac. Ft.
 Capacity Equivalents (Vol.) 400 In.
 Retarding Capacity Provided 20.3 Ac. Ft.
 Capacity Equivalents (Vol.) 150 In.
 Water Supply Provided Ac. Ft. - Identify Uses

Principal Spillway:
 Maximum Capacity (low stage) 43 c.f.s.
 Maximum Capacity (high stage) c.f.s.
 10 Day Drawdown Elev. 56.0
 Emergency Spillway:
 Percent Chance Use 4 Storm Duration 6 Hours
 Type Vegetated Earth "n" Value Used 0.04
 Emergency Spillway Hydrograph for Class "A" Structures
 Rainfall 5.50 in.
 Runoff 3.33 in.
 Peak Inflow 498 c.f.s.
 Maximum Discharge - Emergency Spillway 36 c.f.s.
 Maximum Water Surface Elev. 58.86
 Velocity of Flow (Vel) 3.7 f.p.s.
 Supplementary Data and Special Design Features:

Principal Spillway Crest Elev. = 56.0
 Emergency Spillway Crest Elev. = 58.9
 Emergency Spillway Bottom Width = 40'
 Settled Top of Dam Elev. = 60.3
 $H \times S = 27.7 \times 75.4 = 1749$

Freeboard Hydrograph for Class "A" Structures
 Rainfall 0.01 in.
 Runoff 1.63 in.
 Peak Inflow 697 c.f.s.
 Maximum Discharge - Emergency Spillway 63 c.f.s.
 Maximum Water Surface Elev. 59.76
 Reservoir Capacity

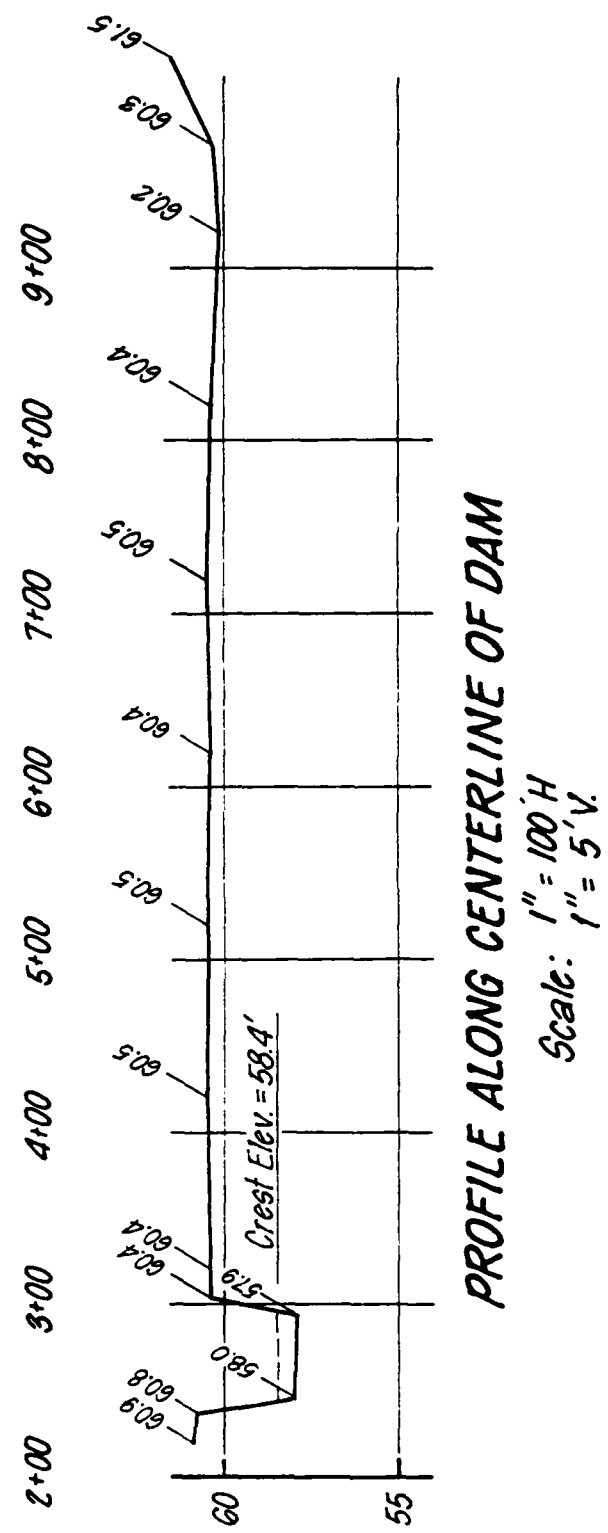
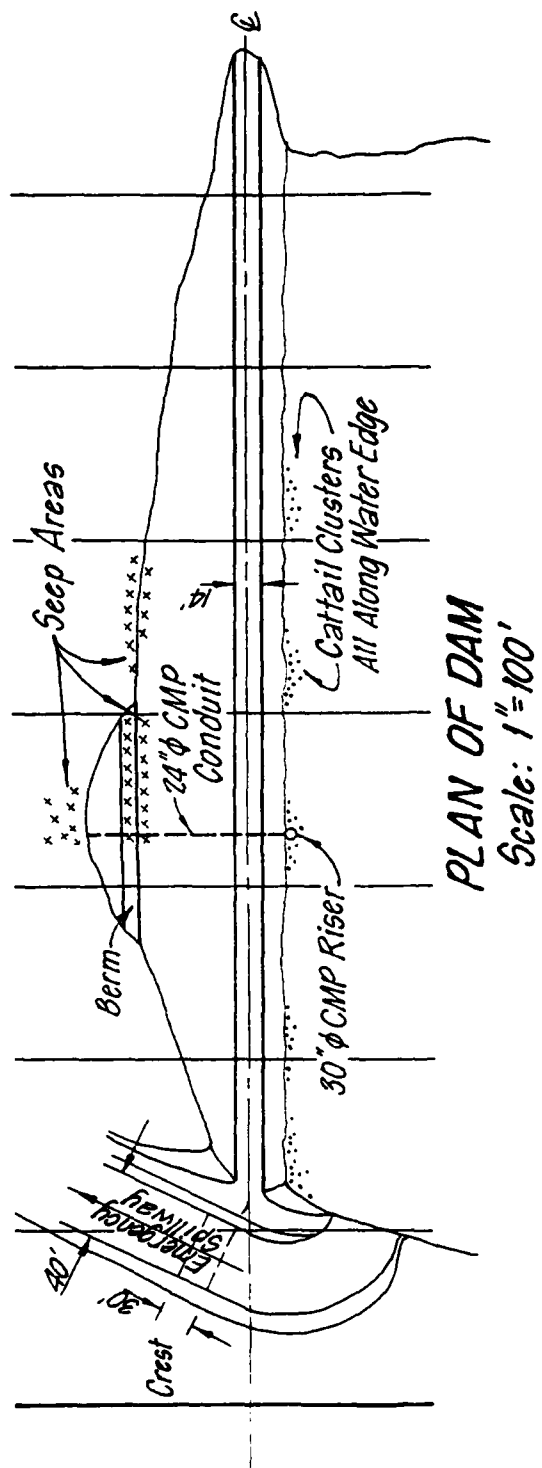


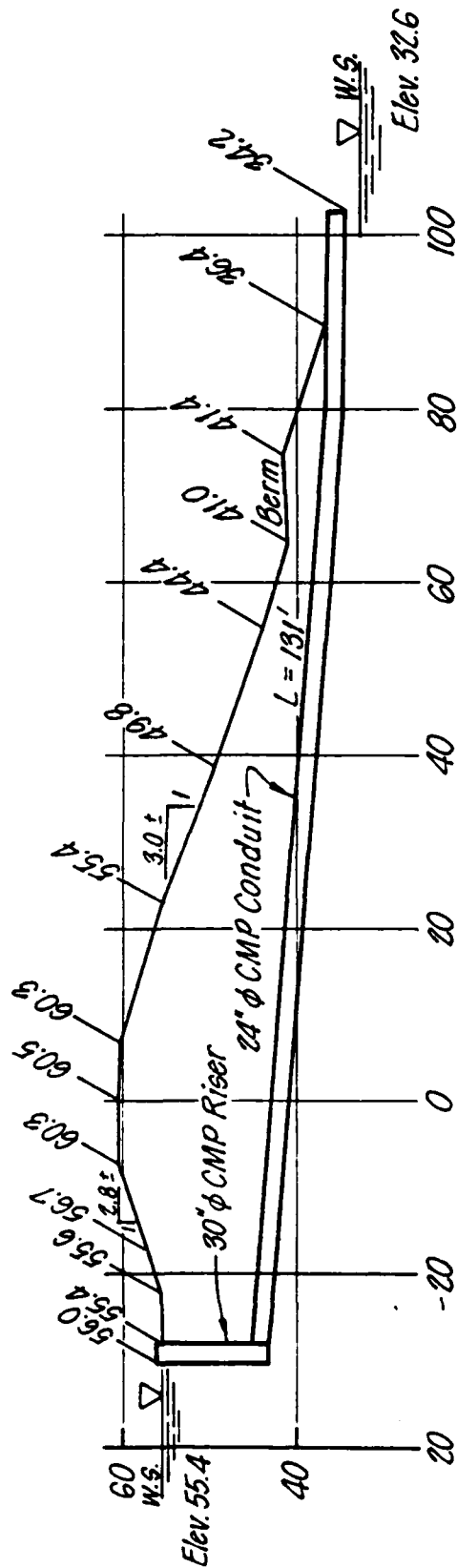
AS BUILT

Total Storage - Ac. Ft.

Supplementary Data and
 Special Design Features:

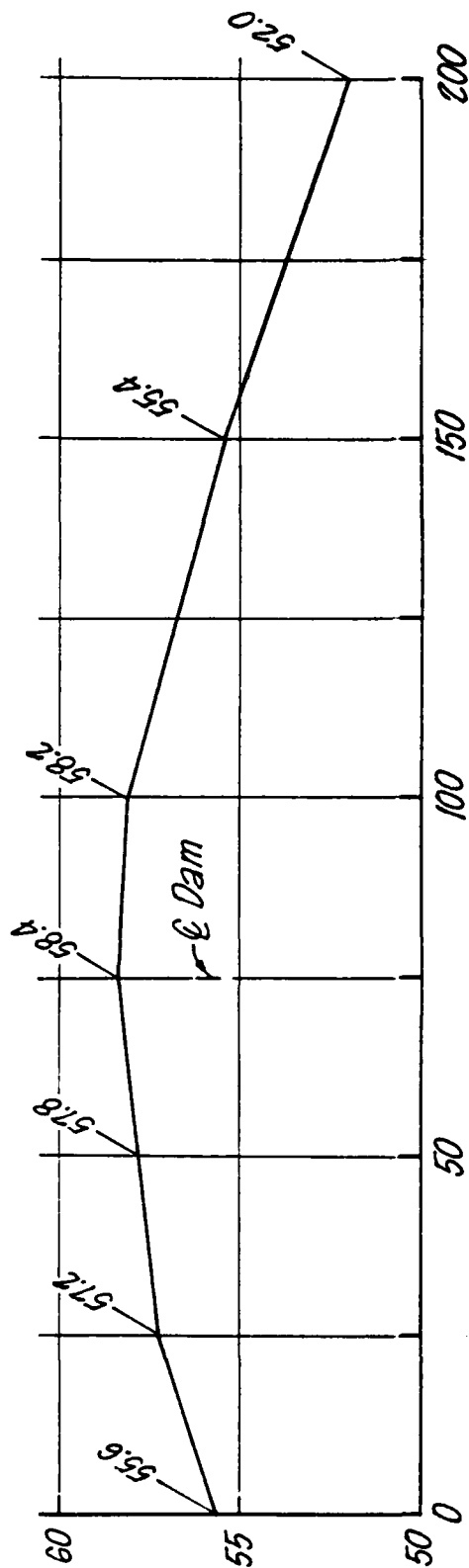
STRUCTURE F-20	
GRANDSTONE-LOST-MUDDY CREEK	
WATERSHED PL 566 DAVIES CO. MD.	
U. S. DEPARTMENT OF AGRICULTURE	
SOIL CONSERVATION SERVICE	
Drawn by	DATE
Checked by	DATE
Approved by	DATE





MAXIMUM CROSS-SECTION OF DAM AT STA. 5+30

Scale: 1" = 20'



PROFILE ALONG CENTERLINE OF EMERGENCY SPILLWAY

Scale: 1" = 25' H.
1" = 5' V.

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See this Appendix).
 - a. Twenty-four hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Chillicothe, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 4 March 1980. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology. The rainfall distribution is inherent in the HEC-1 (Dam Safety Version) computer program and is distributed according to EM 1110-2-1411 (See Section 4a).
 - b. Drainage area = 0.253 square miles (162.0 acres).
 - c. Time of concentration of runoff = 15 minutes (taken from the SCS "as-built" plans, and compared to 18 minutes as computed by the Kirpich formula).
 - d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the one percent probabilistic precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway.
 - e. The total twenty-four hour storm duration losses for the one percent probabilistic storm were 2.33 inches. The total losses for the PMF storm were 1.16 inches. These data are based on SCS runoff curve No. 80 and No. 91 for antecedent moisture conditions SCS AMC II and AMC III respectively. The watershed is composed of primarily SCS soil groups C and D (Lamoni-Shelby-Zook soil association) with approximately 75% in grass and woods and the remainder under cultivation in legumes. Almost the entire watershed is contoured.
 - f. Average soil loss rates = 0.05 inch per hour approximately (For PMF storm, AMC III).
2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.
 - a. The principal spillway rating was developed by using the weir, orifice and full conduit flow equations.

(1) Weir Flow equation ($Q = CLH^{1.5}$)
where C = weir coefficient = 3.4 (from USGS TWRI, Bk. 3, Ch. A5)
L = effective weir length, ft. = 7.8
H = total head, ft.

(2) Orifice equation - $Q = CA\sqrt{2gh}$
where C = orifice coefficient = 0.6
A = area of riser, sq. ft. = 4.9
h = total head, ft.

(3) Full conduit flow equation

$$Q = a \sqrt{\frac{2gH}{1 + K_r + K_p \frac{L}{a}}}$$

where a = cross-sectional area of pipe, $\text{ft}^2 = 3.14$
H = total head, ft.
 K_r = coefficient for riser = 1.0
 K_p = coefficient for pipe friction loss = 0.0459
(ES-42, SCS NEH, Section 5)
L = length of pipe, ft. = 131 (field measurement)

- b. The emergency spillway rating curve was developed using the Corps of Engineers, Water Surface Profile HEC-2 computer program. The slope-area method was used assuming an estimated energy slope of 0.033 ft/ft.
- c. The flows over the dam were determined by using the dam overtopping analyses (irregular top of dam) within the HEC-1 (Dam Safety Version) program.
3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input, output and plotted hydrographs are attached in this Section.

GRINDSTONE-LOST-MUDDY CREEK
DAM F-20
MO. ID. NO. 11220
PRINCIPAL SPILLWAY
RATING CURVE

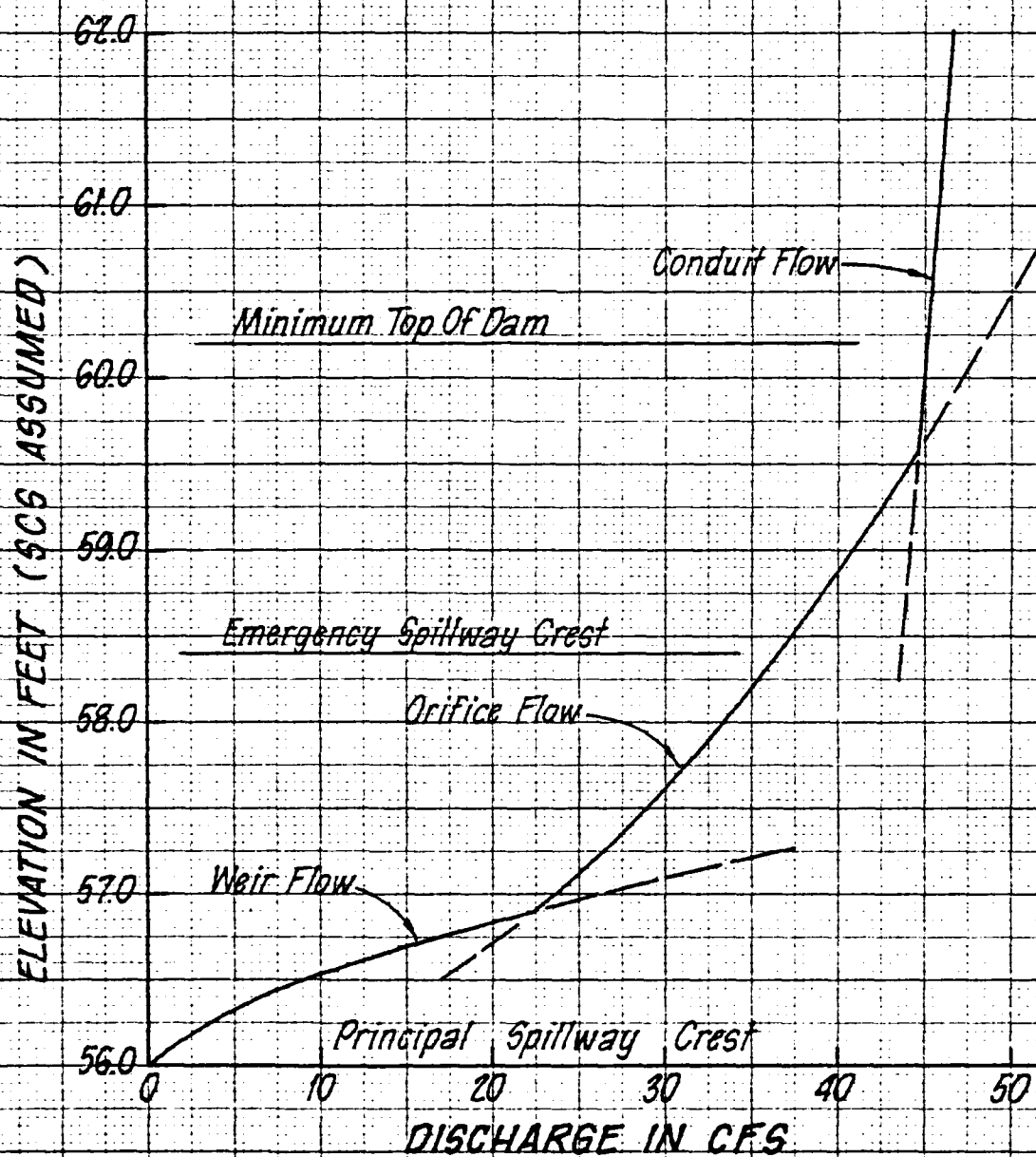
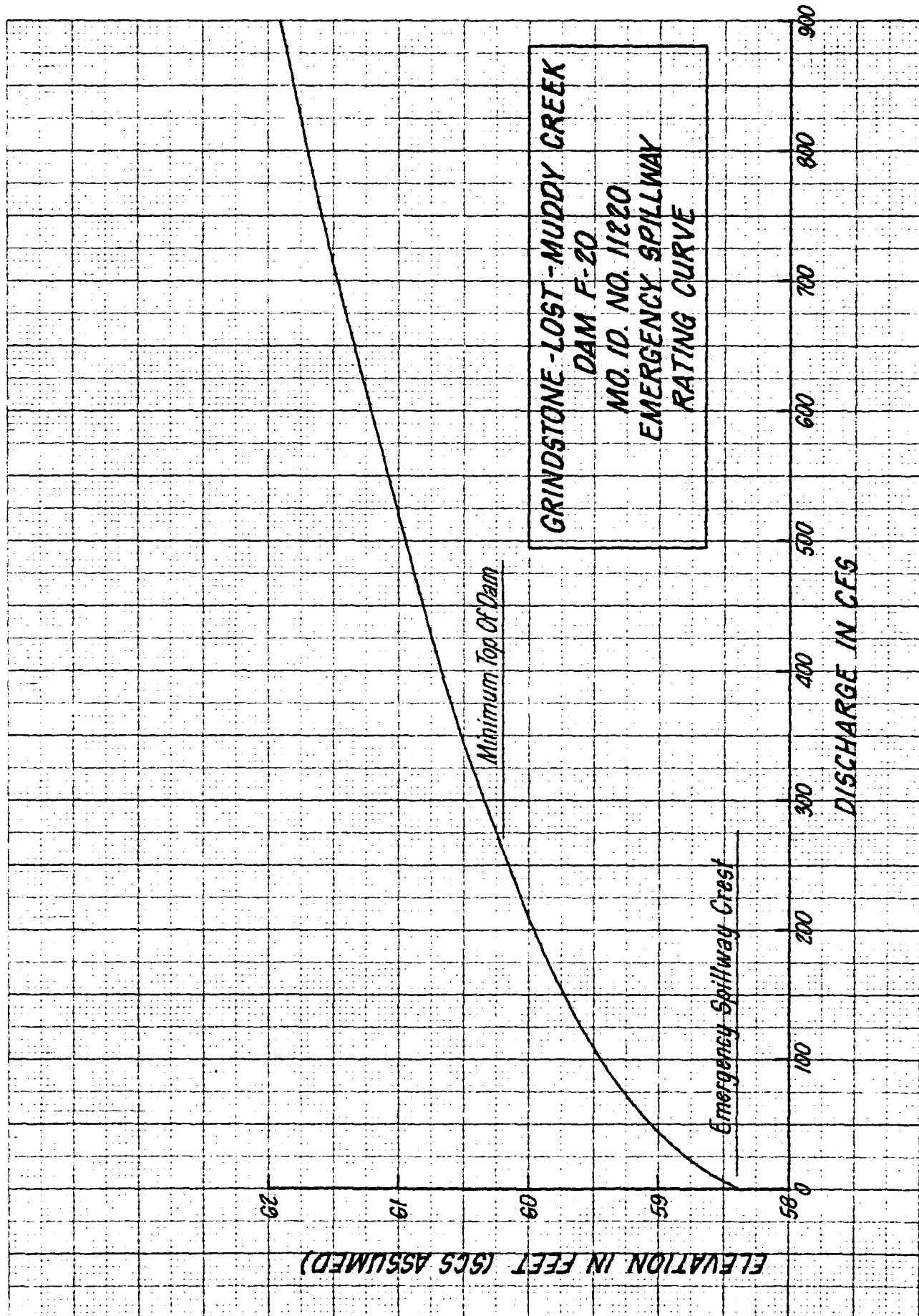
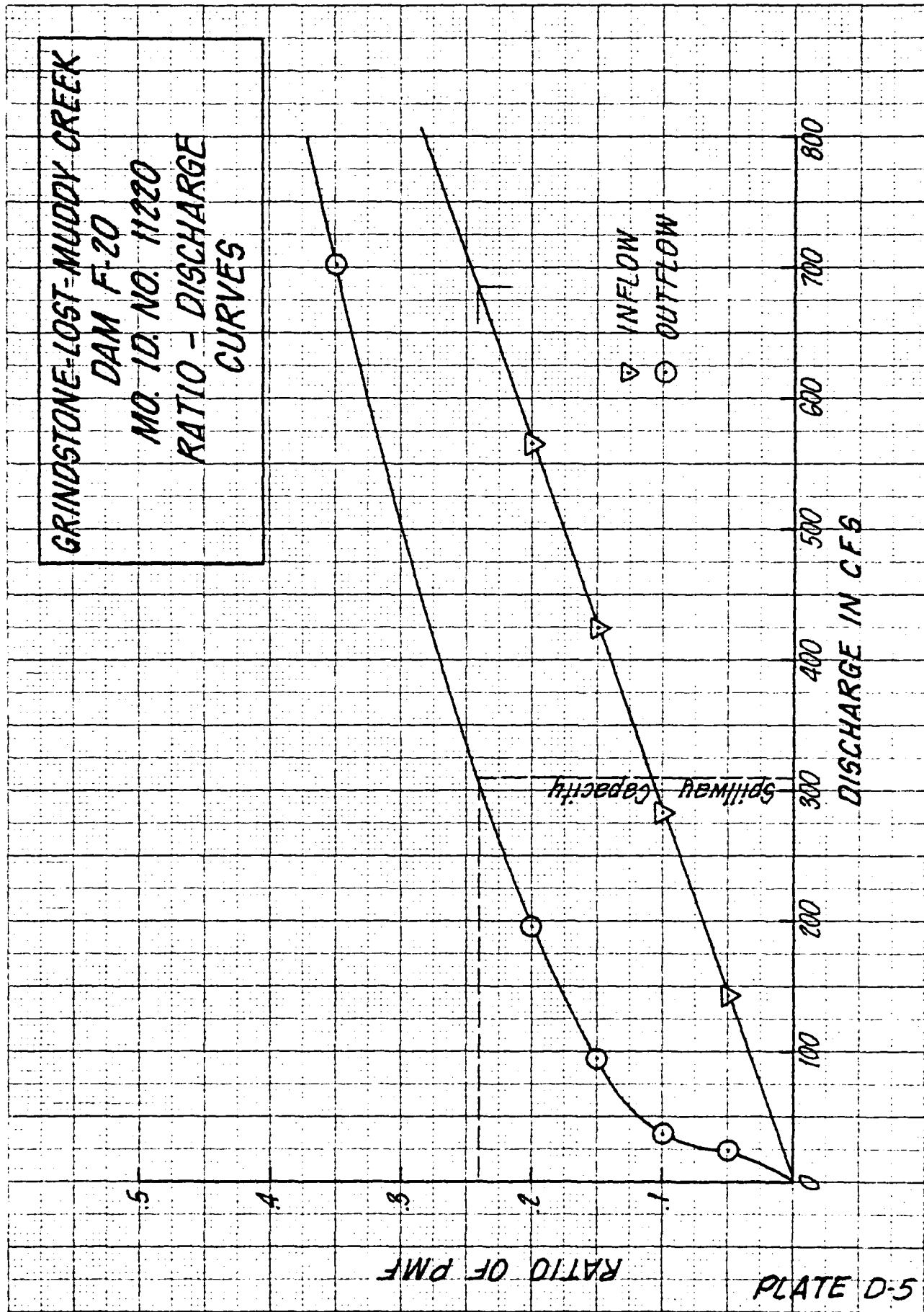


PLATE D-3





[illegible]

 FLOOD HYDROGRAPH PACKAGE (HFC-1)
 DAM SAFETY VERSION JULY 1970
 LAST MODIFICATION 26 FEB 79

RUN DATE# 80/07/28
 TIME# 09.10.55.

GRINDSTONE-LOST-MUDDY CR DAM F-20-MO ID NO 11220
 SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
 H & N ANALYSIS BY ROUTING PHF RATIOS THRU THE RESERVOIR

NO	NHR	NMIN	IDAY	JOPER	JOB SPECIFICATION	IPLT	IPRI	NSTAN
288	0	5	0	5	IHR IMIN METRC	0	3	0
					NWT LROPT TRACE			

MULTI-PLAN ANALYSIS TO BE PERFORMED
 NPLAN= 1 NRTIO= 8 LRTIO= 1

RTIOS=	.05	.10	.15	.20	.35	.50	.75	1.00
--------	-----	-----	-----	-----	-----	-----	-----	------

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDRO TO F-20 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRI	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

INHYG	1	2	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
			.25	0.00	.25	1.00	0.000	0	1	0

SPEC	PMS	R6	R12	R24	R48	R72	R96
0.00	24.10	102.00	121.00	130.00	0.00	0.00	0.00

PRECIP DATA

LROPT	STHCR	DLTKR	RTIOL	ERAIN	STKRS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-91.00	0.00	0.00

CURVE NO = -91.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .17

RECESSION DATA

STRTQ= 0.00 ORCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH	12	END OF PERIOD	ORDINATES, TC=	0.00	HOURS, LAG=	.17	VOL=	1.00
175.	531.	546.	342.	171.	48.	25.	13.	7.
4.	2.							

0

END-OF-PERIOD FLOW

PLATE D-8

[illegible]

[illegible]

HYDROGRAPH AT STA00001 FOR PLAN 1, RTIO 1

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL	VOLUME
141.	33.	10.	10.	2949.	84.
4.	0.	0.	0.		1.51
	1.21	30.26	30.26		30.26
	30.16	20.	20.		20.
	20.	25.	25.		25.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL	VOLUME
282.8	66.2	30.1	20.		5899.
	2.2	1.	1.		167.
	2.42	3.01	3.01		3.01
	61.55	76.51	76.51		76.51
	33.	41.	41.		41.
	40.	50.	50.		50.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

PLATE D-11

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 423. 31. 114. 8848.
 12. 3. 4. 251.
 3. 4. 114. 4.52
 92. 114. 114. 114.77
 49. 61. 61. 61.
 60. 75. 75. 75.
 THOUS CU M

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

CFS
 CMS
 INCHES
 MM
 AC-FT
 THOUS CU M
 PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 564. 41. 114. 11798.
 16. 4. 4. 334.
 4. 6. 6. 6.02
 123. 153. 153. 153.03
 11 81. 81. 81.
 81. 100. 100. 100.
 THOUS CU M

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

CFS
 CMS
 INCHES
 MM
 AC-FT
 THOUS CU M
 PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 988. 72. 114. 20646.
 28. 7. 7. 505.
 8. 19. 19. 10.54
 215. 267. 267. 267.79
 44 142. 142. 142.
 114. 175. 175. 175.
 THOUS CU M

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6 $\frac{1}{2}$ PMF

CFS
 CMS
 INCHES
 MM
 AC-FT
 THOUS CU M
 PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 1411. 102. 114. 23494.
 40. 9. 9. 15.06
 12. 307. 307. 307.56
 12 163. 163. 163.
 202. 251. 251. 251.
 THOUS CU M

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 7

CFS
 CMS
 INCHES
 MM
 AC-FT
 THOUS CU M
 PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 2117. 154. 114. 41241.
 60. 14. 4. 1551.
 18. 22. 22. 22.59
 461. 573. 573. 573.85
 66 305. 305. 305.
 245. 376. 376. 376.
 THOUS CU M

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 8

CFS
 PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 2822. 659. 205. 58988.
 PMF

CMS
INCHES
AC-FI
THOUS CU M

80.

24.23
615.55
327.
403.

30.12
765.13
406.
501.

30.12
765.13
406.
501.

1670
30.12
765.13
406.
501.

HYDROGRAPH ROUTING

ROUTED FLOWS THRU F-20 RESERVOIR

ISTAQ ICOMP IECON ITAPE JPLI JPRPT INAME ISTAGE IAUTO
000002 1 0 0 2 0 0 0

ROUTING DATA
IRES ISAME IOPT IPMP LSTR
1 1 0 0 0

QLOSS CROSS AVG
0.0 0.000 0.00

NSTPS NSTDL
1 0

LAG AMSKK X TSK STORA ISPRAY
0 0.000 0.000 0.000 -56. -1

56.30 56.50 57.90 57.50 58.00 58.40 59.00 59.60
60.20 61.00 62.00

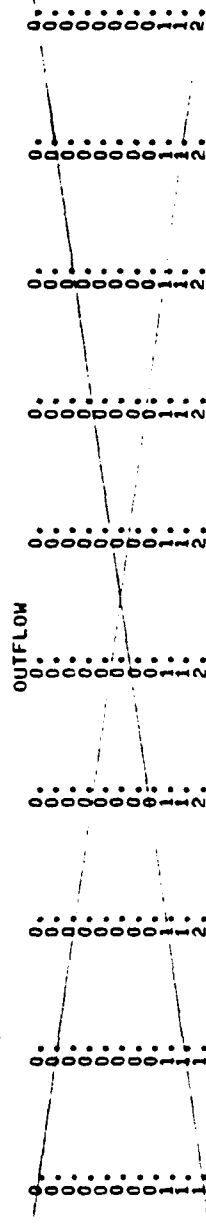
4.40 9.40 22.50 23.60 28.90 36.50 84.00 173.00
310.00 566.00 987.00

0. 5. 18. 47. 55. 74. 98. 125.
38. 45. 50. 55. 56. 58. 60. 62.

CREL SPHID COOH EXPH ELEV COOL CAREA EXPL
56.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DAM DATA
TOPEL COOD EXPD DAMHID
60.2 169. 574. 674. 716. 724.
60.4 60.4 60.5 60.5 61.0 62.0

STATION 000002, PLAN 1, RATIO 1
END-OF-PERIOD-HYDROGRAPH-ORDINATES

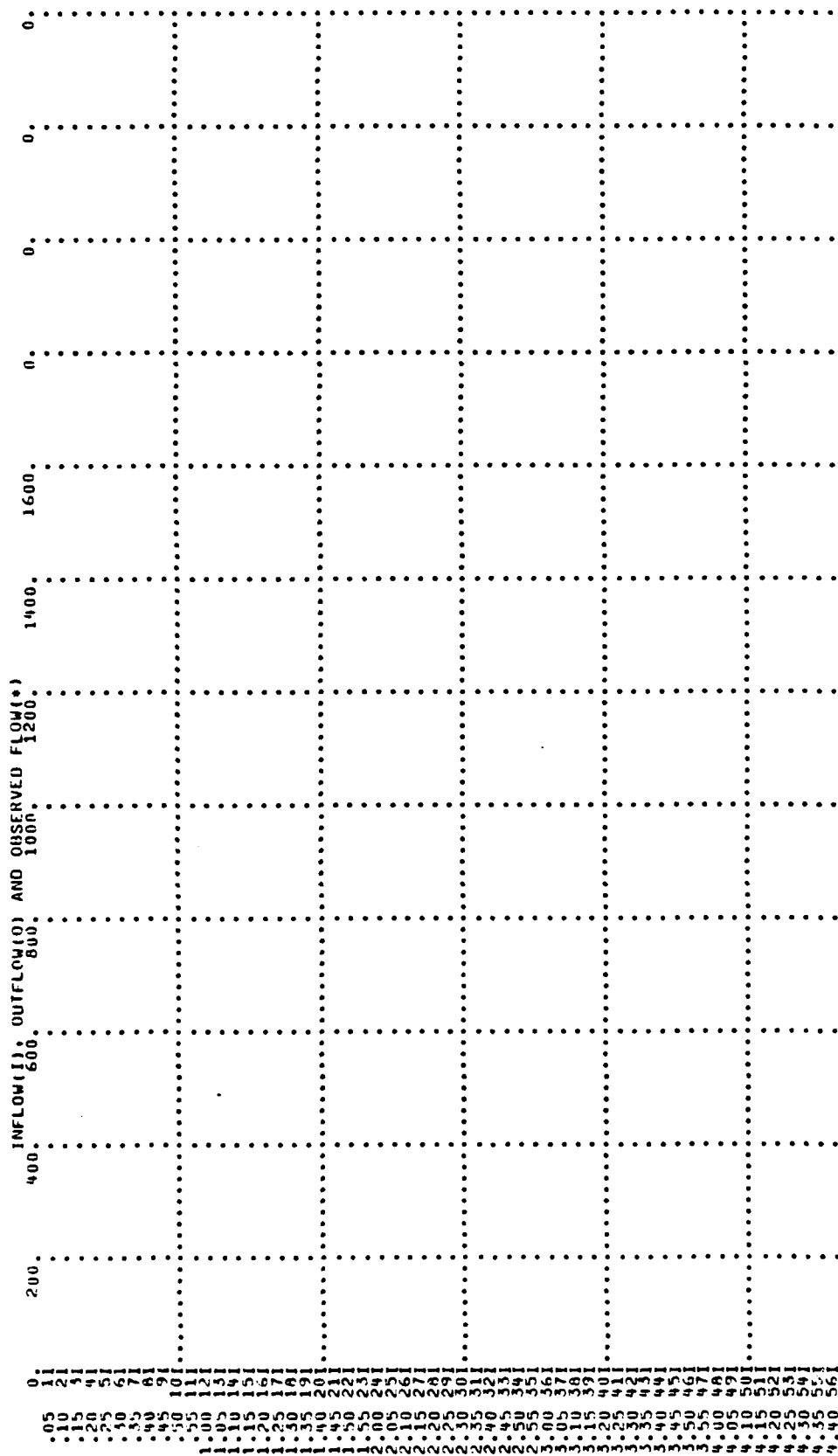


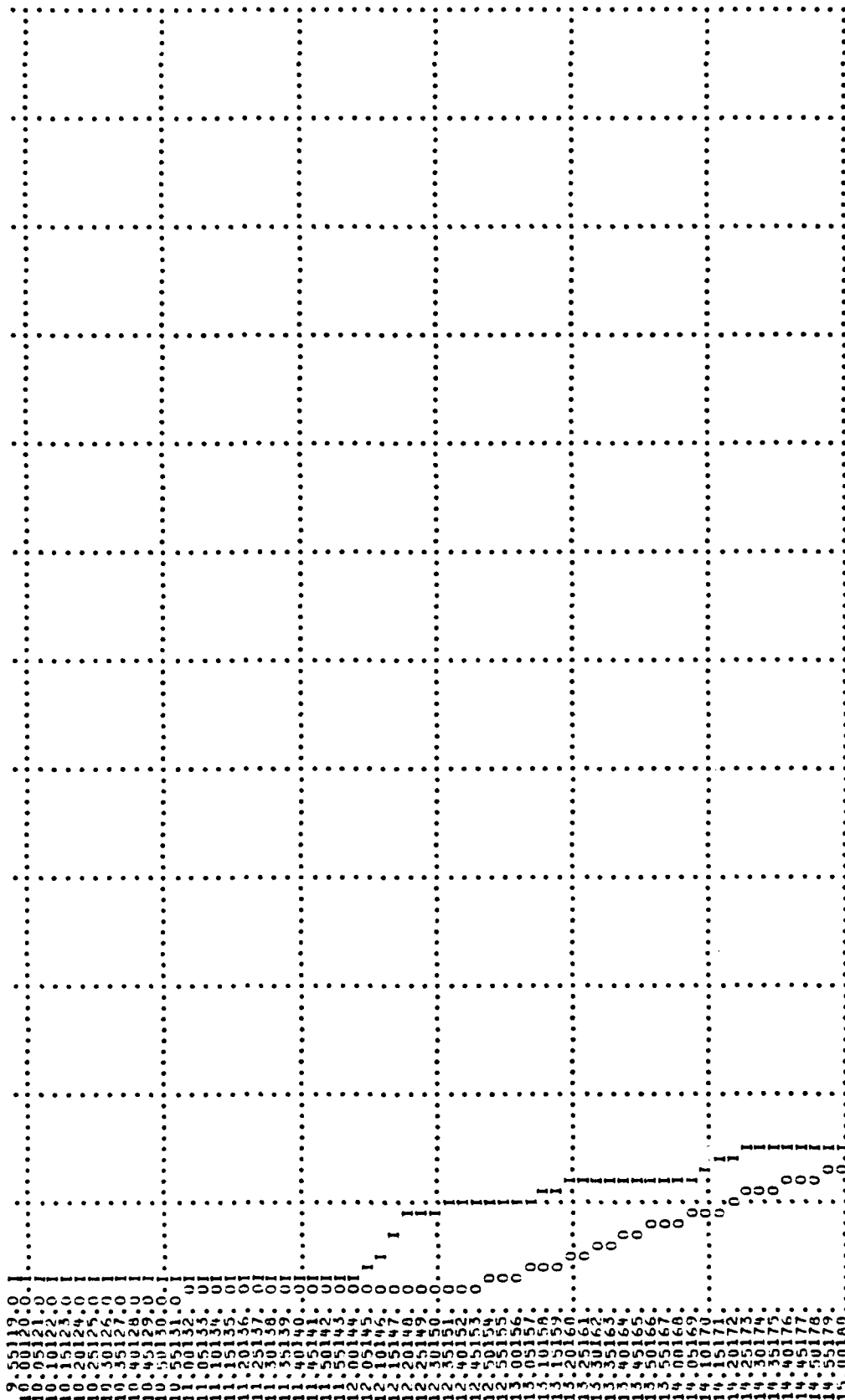
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END-OF-PERIOD HYDROGRAPH ORDINATES[illegible]

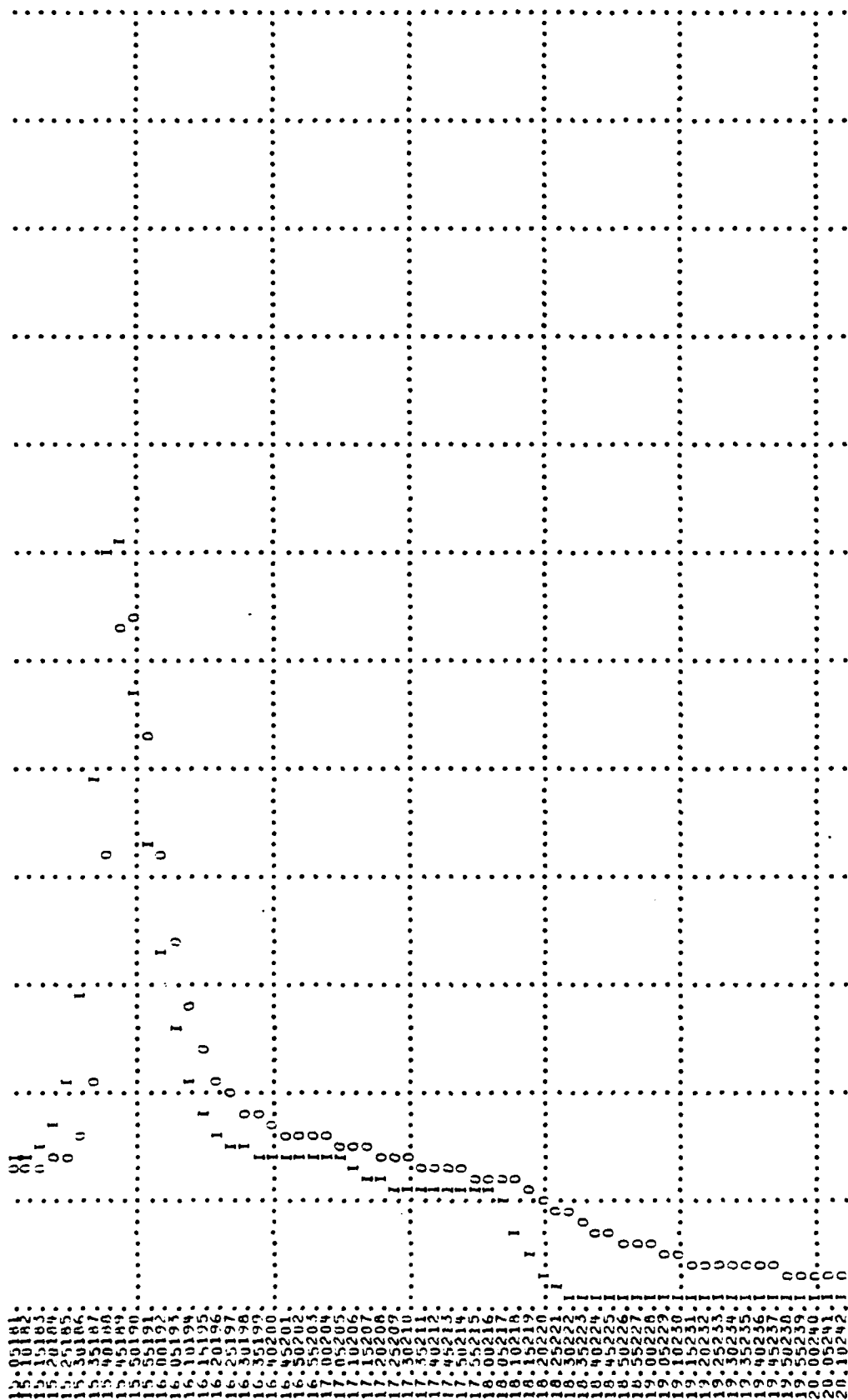
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OVF

STATION000002





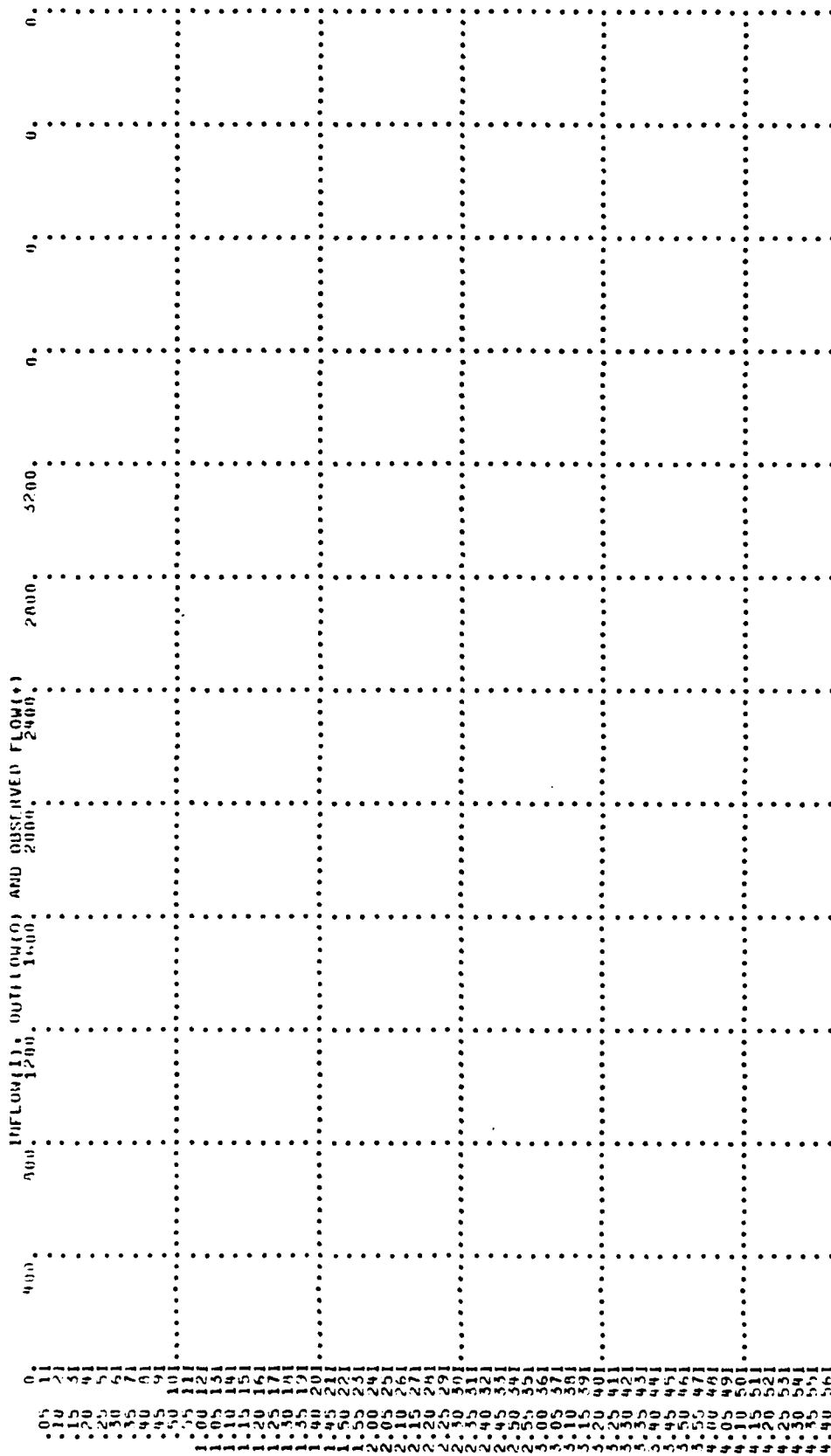


STATION 000002, PLAT 1, RATIO 8 [P M F]
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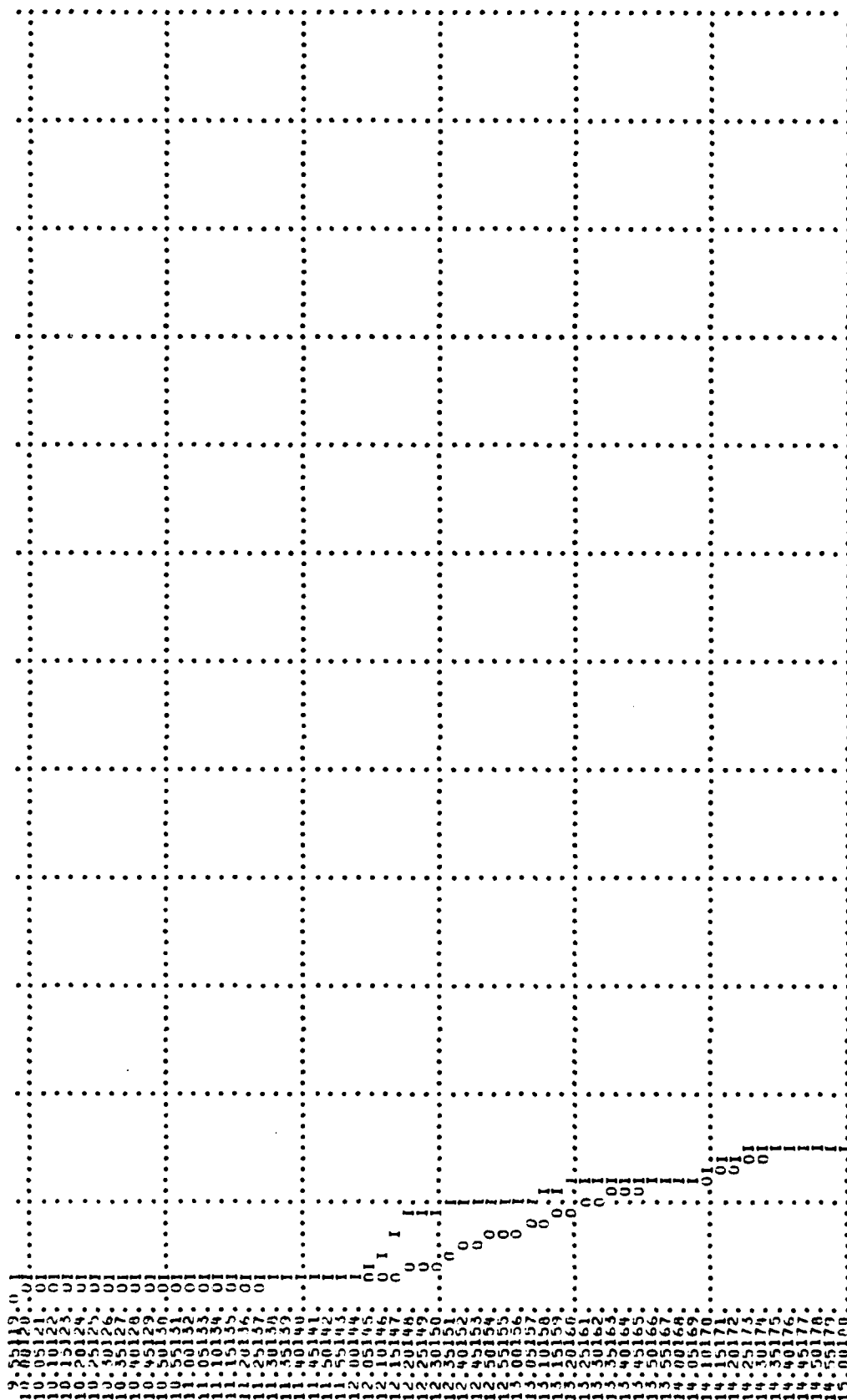
OUEFLOW		STORAGE	
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8.	8.	55.	55.
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80.	80.	55.	55.
80.	80.	55.	55.
81.	81.	55.	55.
81.	81.	55.	55.
82.	82.	55.	55.
82.	82.	55.	55.
83.	83.	55.	55.
83.	83.	55.	55.
84.	84.	55.	55.
84.	84.	55.	55.
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85.	85.	55.	55.
86.	86.	55.	55.
86.	86.	55.	55.
87.	87.	55.	55.
87.	87.	55.	55.
88.	88.	55.	55.
88.	88.	55.	55.
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90.	90.	55.	55.

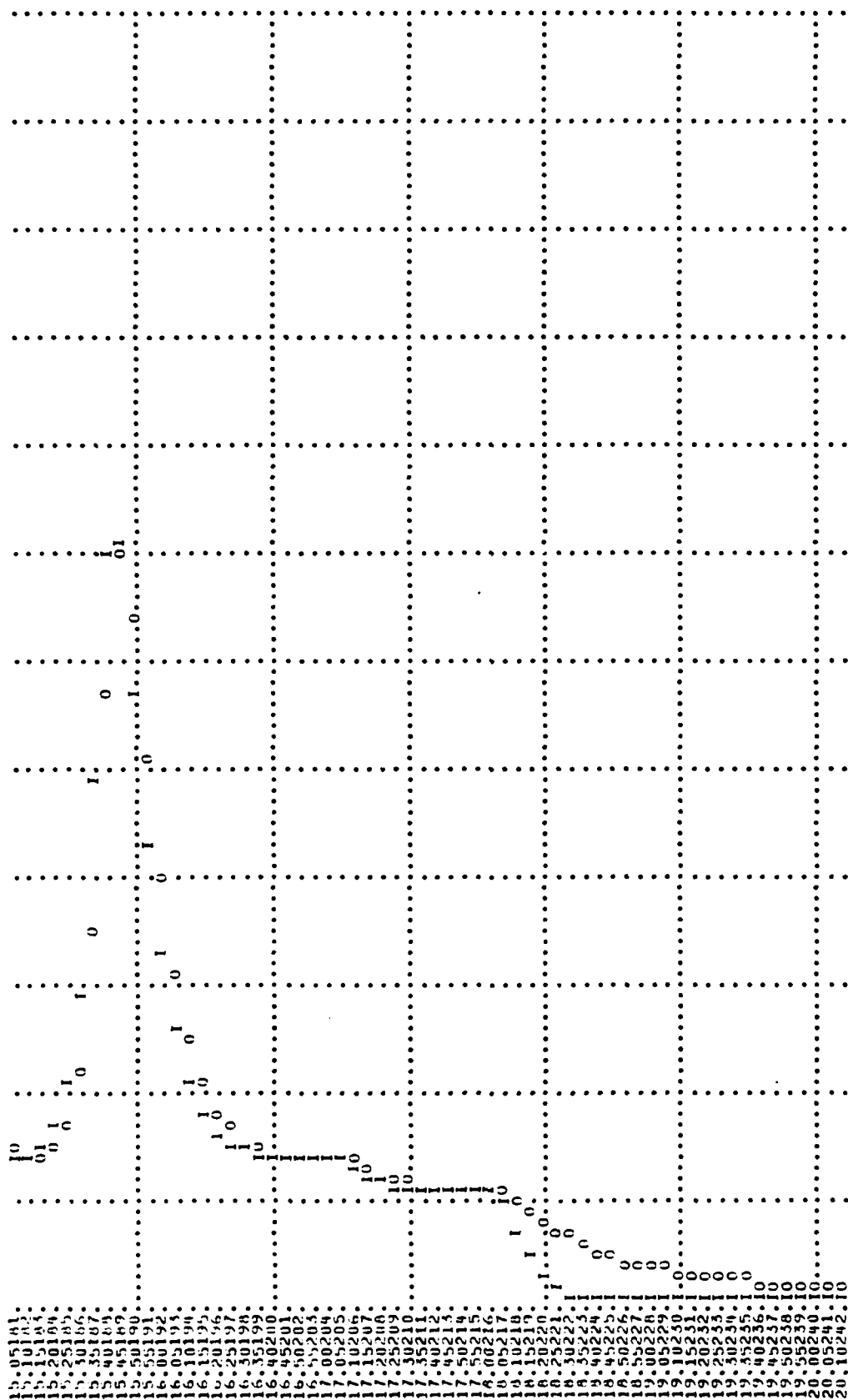
• DVF •

STATION 000002



[illegible]





PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
				.05	.10	.15	.20	.35	.50	.75	1.00
HYDROGRAPH AT	000001	.25	1	141.	282.	423.	564.	988.	1411.	2117.	2822.
		.661	(	4.00)(	7.99)(	11.99)(	15.98)(	27.97)(	39.96)(	59.94)(	79.92)(
ROUTED TO	000002	.25	1	25.	37.	94.	196.	701.	1270.	2055.	2785.
		.661	(	.72)(	1.06)(	2.67)(	5.55)(	19.05)(	35.98)(	58.20)(	78.87)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAU 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM			
		56.00	56.00	60.20			
		55.	55.	101.			
		0.	0.	310.			
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	57.16	0.00	66.	25.	0.00	17.17	0.00
.10	58.41	0.00	79.	37.	0.00	16.06	0.00
.15	59.07	0.00	87.	94.	0.00	16.33	0.00
.20	59.71	0.00	95.	196.	0.00	16.08	0.00
.35	60.65	.45	107.	701.	.15	15.63	0.00
.50	60.91	.71	110.	1270.	1.36	15.03	0.00
.75	61.18	.98	114.	2058.	4.25	15.75	0.00
1.00	61.40	1.20	117.	2785.	5.25	15.75	0.00

APPENDIX E

GEOLOGICAL INVESTIGATION, SOILS REPORT
AND ENGINEER'S REPORT
USDA-SCS
1968

APPENDIX E

DIVISION I

DETAILED GEOLOGIC INVESTIGATION
OF DAM SITES
USDA-SCS
NOVEMBER, 1968

10-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State IN County Delaware ; SW $\frac{1}{4}$ Sec. 30, T. 29 N., R. 29 W.; Watershed San Antonio
Subwatershed _____ Fund class 100-03-11 Site number E-20 Site group I Structure class _____
(FP-2, WP-1, etc.)
Investigated by _____ Equipment used _____ Date 11-1-68
(signature and title) _____ (Type, size, make, model, etc.)

SITE DATA

Drainage area size 25 sq. mi., 162 acres. Type of structure DT 24" CMP Purpose Storage
Direction of valley trend (downstream) SE Maximum height of fill 25 feet. Length of fill 500 feet.
Estimated volume of compacted fill required 26,500 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	<u>55.1</u>	<u>9.2</u>	<u>20.7</u>
Floodwater	<u>20.3</u>	<u>10.1</u>	<u>23.0</u>

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Dissected Tertiary Topography rolling Attitude of beds: Dip _____ Strike _____
Steepness of abutments: Left 11 percent; Right 12 percent. Width of floodplain at centerline of dam _____ feet
General geology of site: The site is located on a floodplain composed of recent alluvium.

The alluvium is composed of sand, silt, and clay. The sand is well-sorted and medium-grained. The silt and clay are fine-grained and highly plastic.
There is no evidence of any bedrock or other hard material at the surface.

There is sufficient borrow material available within 400 feet of the dam site.

Grindstone - Lost - Muddy
F-20

FORM SCS-376B

REV. 2-64

SHEET 2 OF 3

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE 2 Dam, principal Spillway, stream channel, borrow area
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		UNDISTURBED (STATE TYPE)	NUMBER OF SAMPLES TAKEN	
	EXPLORATION	SAMPLING		LARGE	SMALL
6" Slat Auger	12	2		2 L Bag	
2" Split Spoon		1			1 Jar
2 1/2" H.A.	4				
TOTAL	16	3		2	1

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

The abutments are still glacial till. The alluvium of the foundation is predominately still silt clay with some sand clay occurring at depth. Bedrock of shale and siltstone with some interbedded thin limestone beds occurs at shallow depths. The shallow alluvium underlain with shale forms the foundation of the principal spillway. The emergency spillway silt is shallow and in stiff till. Stream channels are dug with channel deposits less than 3' deep.

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED <i>Grindstone</i>		SUBWATERSHED		COUNTY <i>Davies</i>	STATE <i>Mo</i>
SITE NO. <i>F-20</i>	SITE GROUP	STRUCTURE CLASS <i>a</i>		INVESTIGATED BY: (SIGNATURE OF GEOLOGIST) <i>Thos. E. Williams</i>	DATE <i>11-1-67</i>

INTERPRETATIONS AND CONCLUSIONS

No unfavorable geologic conditions were encountered at this site. The emergency spillway cuts will be in the till soil and was not investigated. Borrow areas 101 & 102 are Till. Depth of borrow may be limited on the lower slopes in area 102 because of the water level. Borrow area 103 is alluvium with soil profile development and classified CL below the topsoil. The channels are narrow and shallow and the shallow channel deposits are subject to seasonal change. Limestone cobbles occur in the channel downstream from sections D & E.

Estimated cu/yds of compacted fill available below the crest elevation of the principal is Grid D.

Borrow area	101	2000	cu/yds
	102	7000	cu/yds
	103	16000	cu/yds

APPENDIX E

DIVISION II

SOILS REPORT
USDA-SCS
APRIL, 1968

UNITED STATES GOVERNMENT

*Memorandum*U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TO : James M. Dale, State Conservation Engineer,
SCS, Columbia, Missouri

DATE: April 8, 1969

FROM : Lorn P. Dunnigan, Head, Soil Mechanics Laboratory,
SCS, Lincoln, Nebraska

SUBJECT: EN3 22-5, Missouri WP-08, Grindstone-Lost-Muddy Creek, Site No. F-20
(Davies County)

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 1 sheet.
2. Form SCS-355A, Triaxial Shear Test Data, 1 sheet.
3. Form SCS-352, Compaction and Penetration Resistance, 2 sheets.
4. Form SCS-357, Summary - Slope Stability Analysis, 3 sheets.

DISCUSSIONFOUNDATION

- A. Bedrock: The bedrock at the site consists of shale and siltstone with some interbedded thin beds of limestone at shallow depths. The bedrock is reportedly of Pennsylvanian age.
- B. Soil Classification: The sample from TH 301 is classified as CL material with a liquid limit of 39 and a PI of 20. Both abutments are logged as CL till.
- C. Shear Strength: Undisturbed samples were not submitted from this site. A blow count of 7 from the 7 to 8-foot depth in TH 301 was recorded; and based upon this blow count, design strength parameters of $\phi = 18.5^\circ$, $c = 1150$ psf are suggested. These strength parameters are from site No. D-34 on this watershed.

EMBANKMENT MATERIALS

- A. Classification: The borrow samples submitted are from the upstream borrow area (TH's 102 and 103). Both materials are CL's with liquid limits of 40 (Sample 69W101) and 39 (Sample 69W102). The samples have PI's of 22 and 20, respectively.
- B. Compacted Density: Standard Proctor compaction tests were made. Sample 69W101 (Field No. 102.1) has a maximum dry density of 109.5 pcf and Sample 69W102 (Field No. 103.1) has a maximum dry density of 107.0.

2 -- James M. Dale -- 4/8/69

Lorn P. Dunnigan

Subj: ENG 22-5, Missouri WP-08, Grindstone-Lost-Muddy Creek, Site F-20

- C. Shear Strength: A consolidated un drained shear test was made on Sample 69WL301 (Field No. 102.1) compacted to average density of 101.5 pcf, which is 92.6 percent of standard Proctor. The test is interpreted to yield shear strength parameters of $\phi = 5.5^\circ$, $c = 625$ psf. Sample 69W65, from Site No. B-36 Grindstone-Lost-Muddy, which closely approximates the alluvial materials on this site (F-20) has strength parameters of $\phi = 6.5^\circ$, $c = 825$ psf.

SLOPE STABILITY

- A. Maximum Section at Station 7+87. A 27.3-foot high embankment was analyzed considering drying cracks to the phreatic surface in all the modified Swedish circle method trials. In addition, the upstream analysis considers rapid drawdown from the emergency spillway elevation to the base of the embankment, no berm, and embankment shear strength parameters of $\phi = 5.5^\circ$, $c = 625$ psf. Under these conditions a minimum factor of safety of 1.69 was computed. The upstream analysis considered 2 1/2:1 embankment slopes.

The downstream stability analysis considerations are identical to the upstream with the exception that a full phreatic surface (no drain) is considered in place of rapid drawdown. A factor of safety of 1.76 was obtained for the downstream 2 1/2:1 slope.

- B. Floodplain Section at Station 6+50. A 19.3-foot upstream embankment was analyzed considering an 11-foot depth of compressible foundation material. Factors of safety above 3.0 were obtained for this analysis and are fully described on the attached Summary - Slope Stability Analysis, Grindstone-Lost-Muddy Site No. F-20.

RECOMMENDATIONS

- A. Cutoff Trench: We concur with the engineer's recommended cutoff trench depths. The cutoff trench will bottom in CL till and CL alluvium in the abutments, left channel section, and the floodplain. The trench will bottom in bedrock in the right channel section.
- B. Principal Spillway: At the proposed location the foundation consists of about 10 feet of 7-blow-count material overlying bedrock. Based on blow count, foundation consolidation is expected to be low for the proposed fill height.
- C. Drain: The trench will bottom in stiff to medium CL ($n = 7$) and good cutoff is anticipated with the cutoff trench depths recommended in the engineer's report for this site, and a drain is not considered necessary.

3 -- James M. Dale -- 4/8/69

Lorn P. Dunnigan

Subj: EWS 22-5, Missouri WP-08, Grindstone-Lost-Muddy Creek, Site F-20

D. Embankment Design:

1. Placement of Materials: The borrow samples submitted have about the same liquid limits. We concur with the engineer's recommendation that the higher plasticity materials be utilized in the interior portions of the embankment fill and the less plastic materials be utilized as a blanket to reduce the possibility of drying cracks and promote vegetative cover.

All materials should be placed at a minimum of 90 percent of standard Proctor density with moisture controlled near optimum.

2. Slopes: With the embankment at 90 percent of Proctor and no drain, the proposed 2 1/2:1 slopes are expected to be stable.
3. Settlement: An overfill allowance of 0.5 foot is suggested to compensate for residual consolidation within the foundation and embankment.

Prepared by:

Gerald N. Gibson

Reviewed and Approved by:

Lorn P. Dunnigan

Attachments

cc:

Project Office, Maysville, Missouri (2)

E. D. Butler, Lincoln, Nebraska

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAxIAL SHEAR TEST
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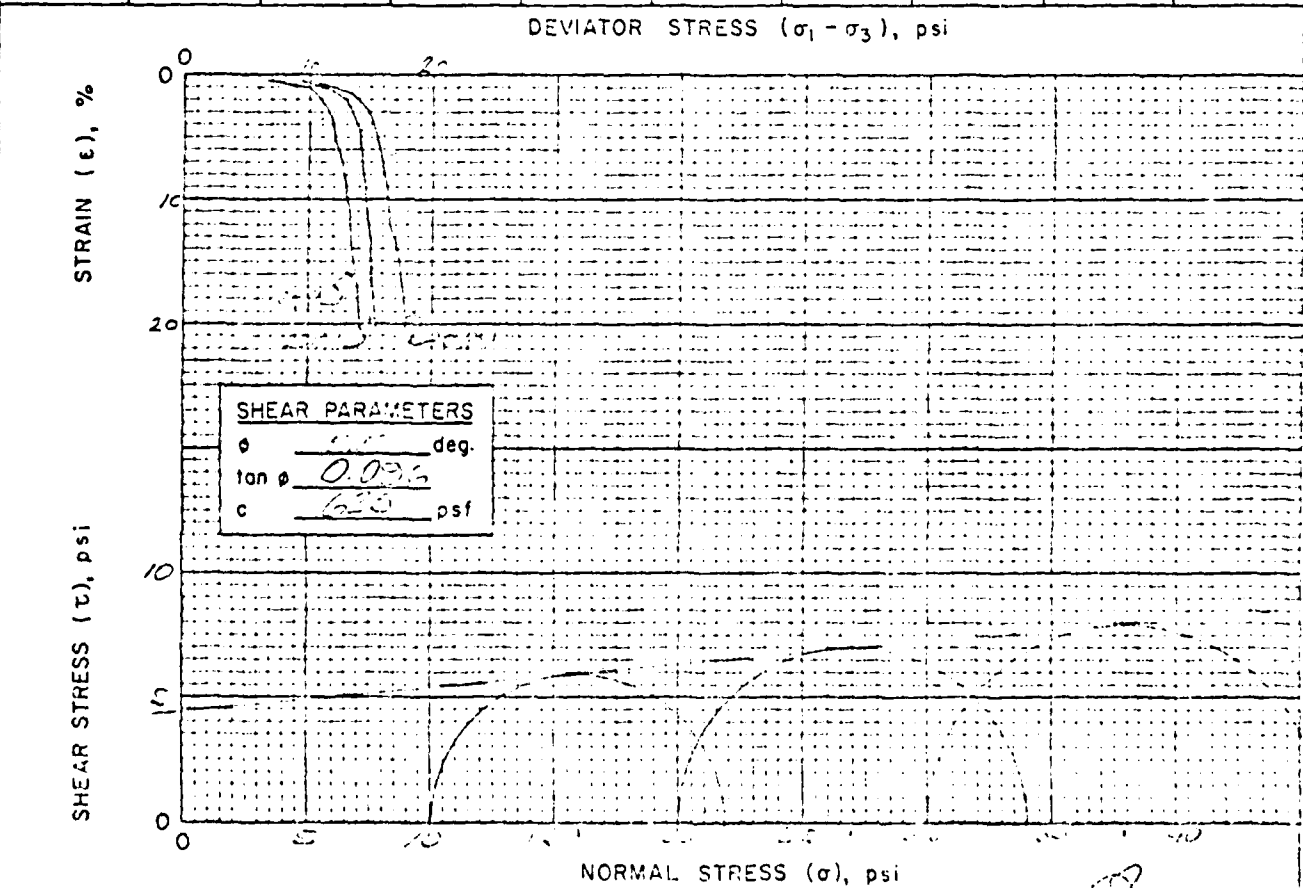
PROJECT and STATE <u>GRAVSTONE LOFT MUDDY F-20 MISSOURI</u>	SAMPLE LOCATION <u>BENTON, ST-40, ST-30</u>
--	--

FIELD SAMPLE NO. <u>102.1</u>	DEPTH <u>1-8'</u>	GEOLOGIC ORIGIN <u>TILL</u>
----------------------------------	----------------------	--------------------------------

TYPE OF SAMPLE <u>COMPACTED</u>	TESTED AT <u>SML LINCOLN</u>	APPROVED BY <u>[Signature]</u>	DATE <u>3-28-69</u>
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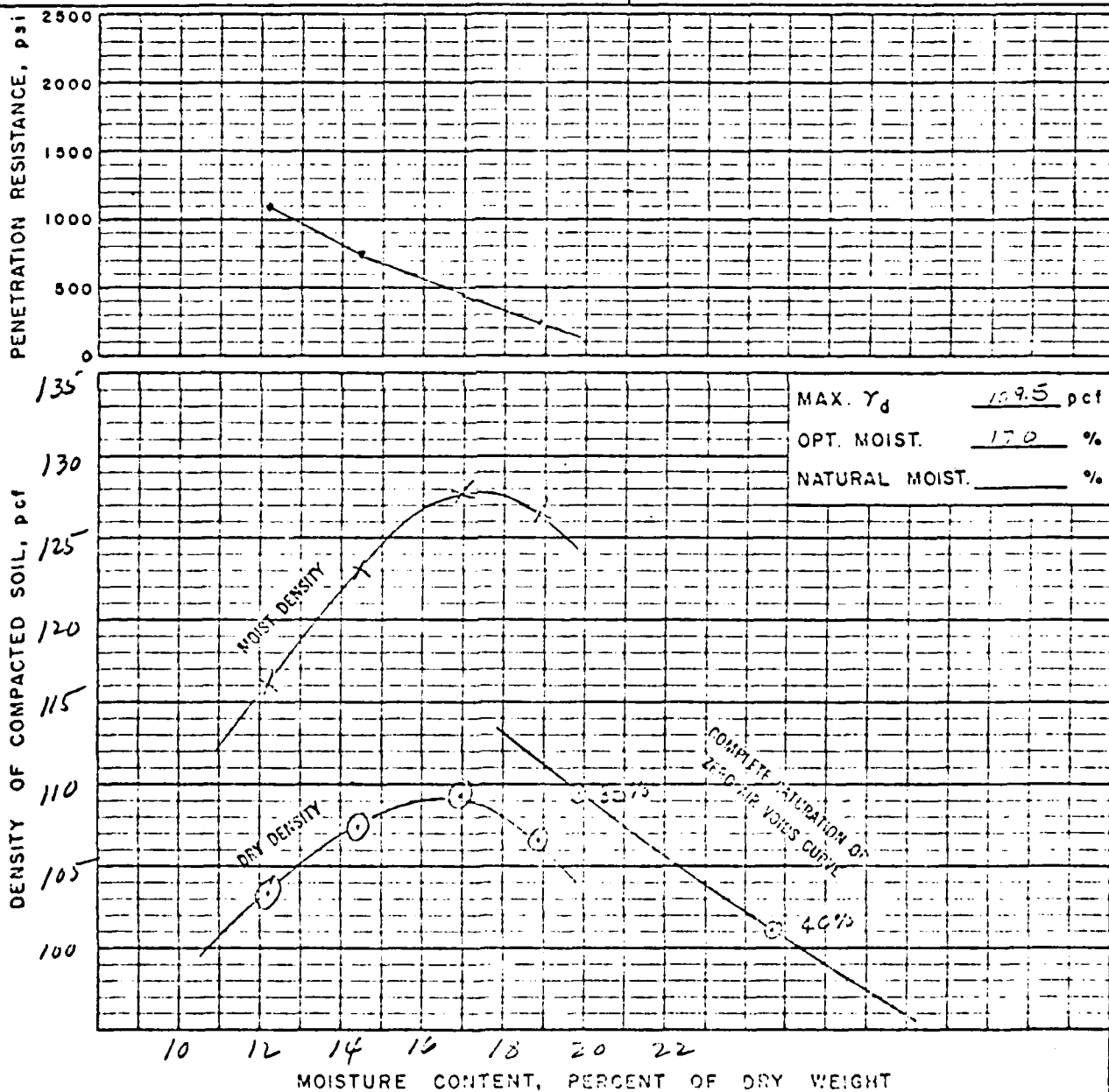
INDEX TEST DATA	SPECIMEN DATA	TYPE OF TEST
USCS <u>CL</u> ; LL <u>40</u> ; PI <u>22</u> % FINER (mm): 0.002 <u>31</u> ; 0.005 <u>37</u> ; 0.075 (#200) <u>79</u> G _s (-#4) <u>2.70</u> ; G _s (+#4) _____ STANDARD: Y _d MAX. <u>109.5</u> pcf; w ₀ <u>17.0</u> % MODIFIED: Y _d MAX. _____ pcf; w ₀ _____ %	HEIGHT <u>3.0</u> "; DIAMETER <u>1.4</u> " MATERIALS TESTED PASSED <u>#4</u> SIEVE METHOD OF PREPARATION <u>STATIC 3</u> <u>LAYER COMPACTION AND SOAKED</u> MOLDING MOISTURE <u>14.5</u> % MOLDED AT <u>90.0</u> % OF Y _d MAXIMUM	UU <input type="checkbox"/> CU <input checked="" type="checkbox"/> CU <input type="checkbox"/> CD <input type="checkbox"/>

DRY DENSITY		MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs)	MINOR PRINCIPAL STRESS σ ₃ (psi)	DEVIATOR STRESS σ ₁ - σ ₃ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
INITIAL pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>	CONSOLIDATED pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>	START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
102.2	102.7	23.0	95.2	22.7	6.55	10	1.5	2.2
100.5	101.2	23.2	92.4	22.6	5.65	20	1.1	4.4
101.4	103.0	23.5	92.3	22.5	6.82	30	1.5	4.1



REMARKS AVERAGE TEST $\gamma_d = 92.6$ % STD.

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		COMPACTION AND PENETRATION RESISTANCE	
PROJECT and STATE <u>Grindstone Lost Muddy # F-20 ; MISSOURI</u>					
FIELD SAMPLE NO. <u>102.1</u>		LOCATION <u>Borrow, R+00, S+30</u>		DEPTH <u>1.0' - 8.0'</u>	
GEOLOGIC ORIGIN <u>Till</u>		TESTED AT <u>SML-LINCOLN</u>		APPROVED BY <u>G. T. D.</u> DATE <u>3-28-65</u>	
CLASSIFICATION <u>CL</u> <u>LL 40</u> <u>PI 22</u>		CURVE NO. <u>1</u> OF <u>2</u>			
MAX. PARTICLE SIZE INCLUDED IN TEST <u>< #4</u>		STD (ASTM D-698) <input checked="" type="checkbox"/> ; METHOD <u>A</u>			
SPECIFIC GRAVITY (G_s) { MINUS NO. 4 <u>2.70</u>		MOD. (ASTM D-1557) <input type="checkbox"/> ; METHOD <u> </u>			
		PLUS NO. 4 <u> </u> OTHER TEST <input type="checkbox"/> (SEE REMARKS)			



REMARKS

MATERIALS TESTING REPORT	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE
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PROJECT IN STATE Grindstone Lost Muddy # F-20 ; Missouri

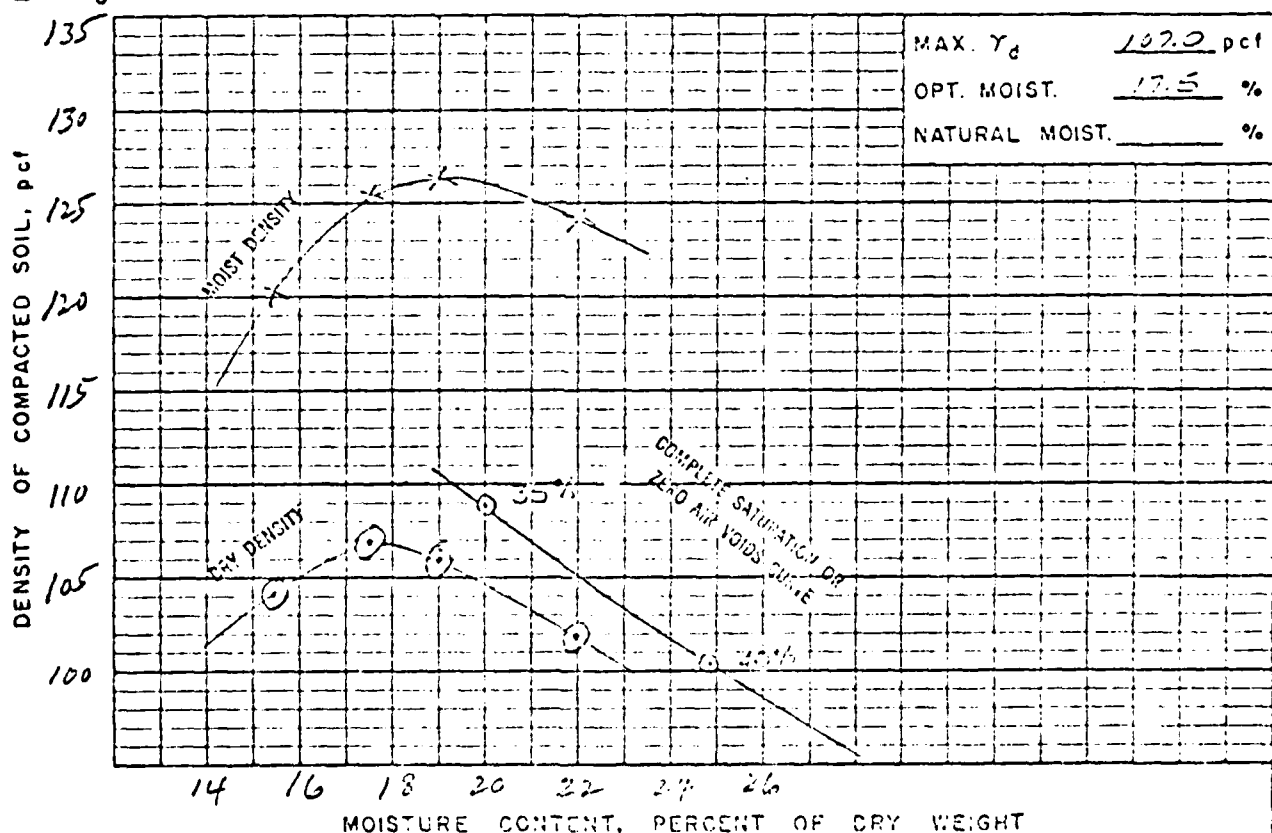
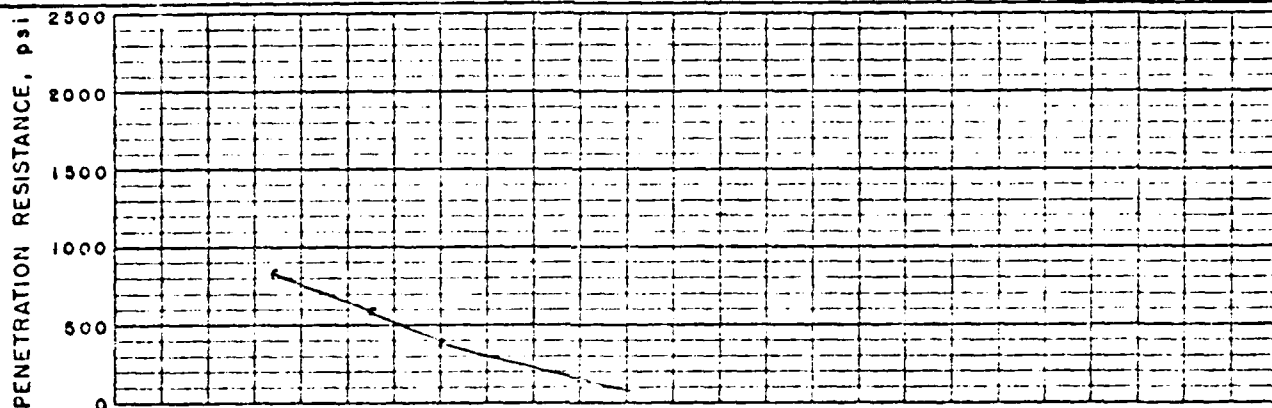
FIELD SAMPLE NO. <u>103.1</u>	LOCATION <u>Borrow, B+00 G+00</u>	DEPTH <u>-3.5'</u>
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GEOLOGIC ORIGIN <u>Alluvium</u>	TESTED AT <u>SML-LINCOLN</u>	APPROVED BY <u>[Signature]</u>	DATE <u>3-28-69</u>
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CLASSIFICATION CL LL 39 PI 20 CURVE NO. 2 OF 2

MAX. PARTICLE SIZE INCLUDED IN TEST 2.5 mm " STD. (ASTM D-698) ☒; METHOD A

SPECIFIC GRAVITY (G_s)	MINUS NO. 4 <u>2.68</u>	MOD. (ASTM D-1557) <input type="checkbox"/> ; METHOD _____ OTHER TEST <input type="checkbox"/> (SEE REMARKS)
	PLUS NO. 4 _____	



REMARKS

MATERIALS TESTING REPORT	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	SUMMARY - SLOPE STABILITY ANALYSIS
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PROJECT and STATE

DATE

METHOD OF ANALYSIS

ANALYZED AT

APPROVED BY

SOURCE AND USE OF MATERIALS		CLASSIFICATION	ADOPTED DESIGN DATA						REMARKS
			γ_d (pcf)	γ_m (pcf)	γ_{sat} (pcf)	γ_{sub} (pcf)	ϕ (deg)	$\tan \phi$	c (psf)
①	Found	C-1	123.5		125.0	22.5	13.5	0.235	1150
②	For haul 5'	C-2	124.5	119.5	125.0	27.5	5.5	0.093	125
③	For haul 10'	C-1	92.7	116.9	122.5	53.5	6.5	0.110	225
④									
⑤									
⑥									
TRIAL NO.	SLOPE	CONDITIONS							
1	25:1	MAXIMUM SECTION STATION 7+37							
2	25:1	Full depth town - No berm - Arc cut from bottom of crack plus emb. (55'-125') only.							
3	25:1	Same conditions as trial #1.							
4	25:1	Same conditions as trial #1.							
5	25:1	No Drain - No berm - Arc cut from bottom of cracks thru emb (125'-125').							
6	25:1								
7	25:1								
8	25:1								
9	25:1								
10	25:1								
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NOTES WITHIN

STATION 7137

SCALE = 1:3750

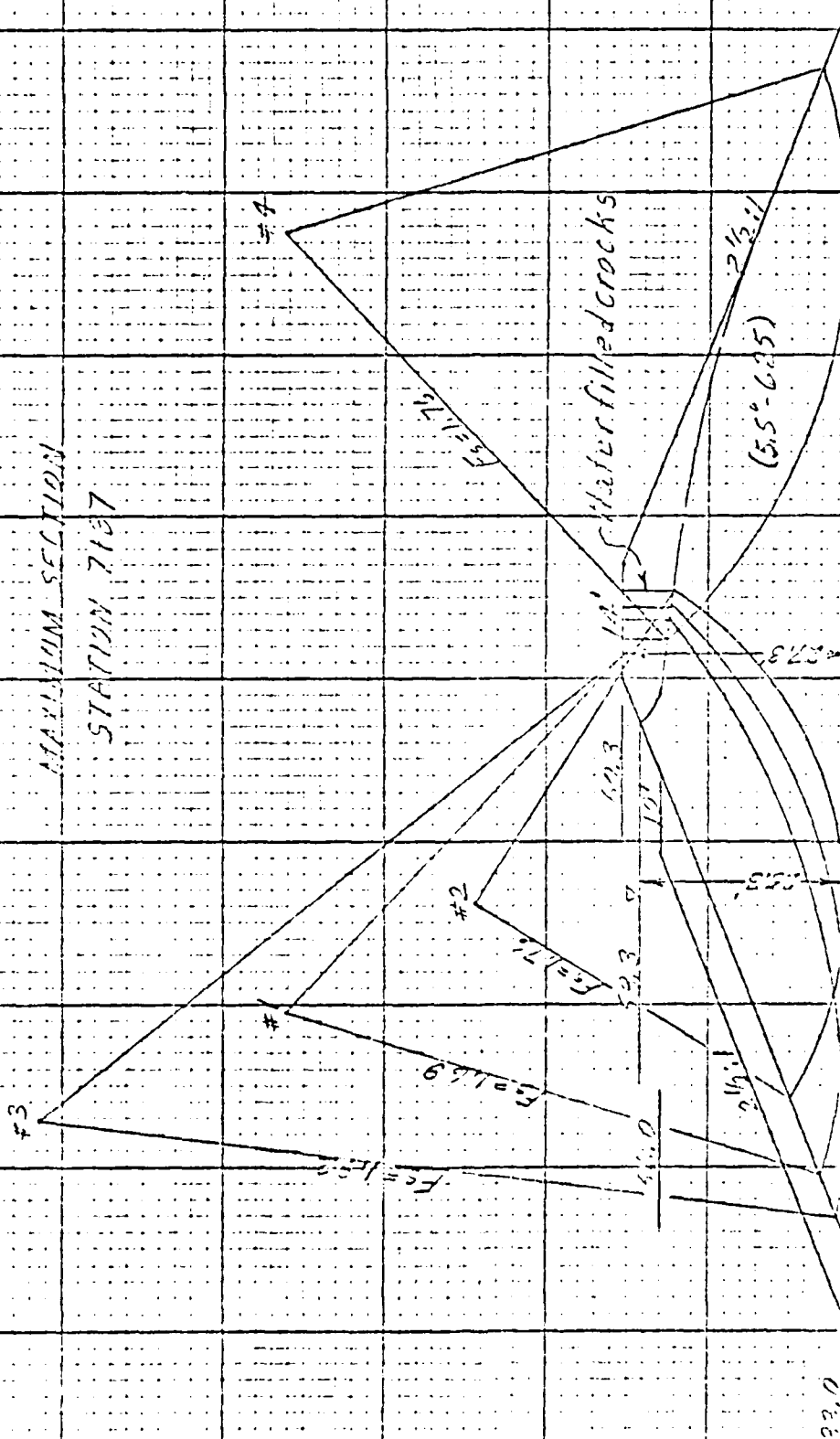
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DESIGNED BY

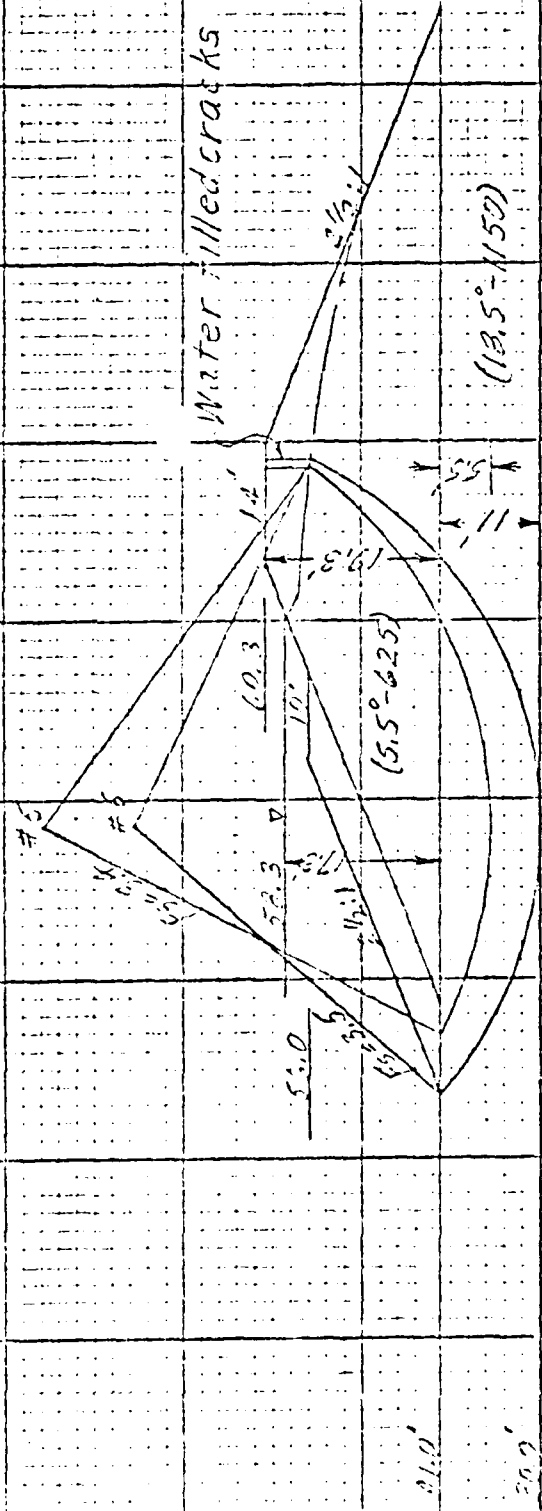
A. W. L.

CHICKED BY

RFH



DATE: 6-1-55



APPENDIX E

DIVISION III

ENGINEER'S REPORT
USDA-SCS
DECEMBER, 1968

AD-A105 278

HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE F/G 13/13
NATIONAL DAM SAFETY PROGRAM. GRINDSTONE-LOST-MUDDY CREEK DAM F---ETC(U)
JUN 80 R S DECKER, G JAMISON, G ULMER DACW43-80-C-0071

UNCLASSIFIED

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A105 278



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Engineer's Report - Investigation of Dam Site F-20
Grindstone-Lost-Muddy Creek

Harold B. Townsend Jr.

12-18-68

Stream channel cleanout is recommended between sections A and B. Cleanout depths of 2.5 ft. to 3 ft., bottom width of 10 ft. and side slopes of 2:1 should be adequate to remove the recent channel fill. Channel cleanout is not recommended for the channel below the centerline of the dam.

Recommended Core:	Stations	Elevations
	3+00	55.0
	4+00	44.0
	4+45	32.0
	4+60	32.0
	5+00	38.0
	5+50	38.0
	6+50	36.0
	7+50	36.0
	7+80	31.0
	7+95	31.0
	9+00	50.0
	9+60	56.0

3:1 End Slopes

Placement of the fill materials from the required excavations and borrowings will be controlled by the engineer. The more plastic CL material to be placed in the core with the ML or top soil in the outer shell to reduce drying cracks and to improve vegetative cover establishment.

The principal spillway conduit will be 24 inch diameter corrugated metal pipe. A pipe drop inlet and cantilevered outlet will be used.

Foundation drainage should not be required with the recommended core depths.

There does not appear to be any special foundation or fill design problems at this site.